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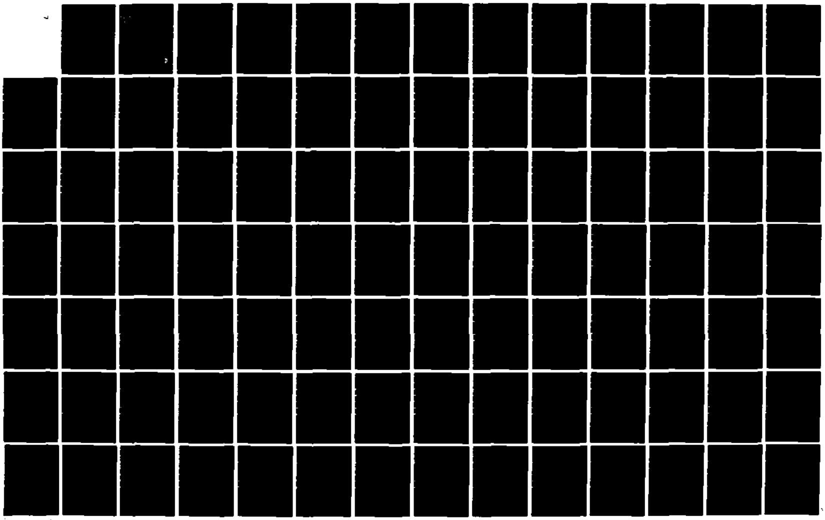

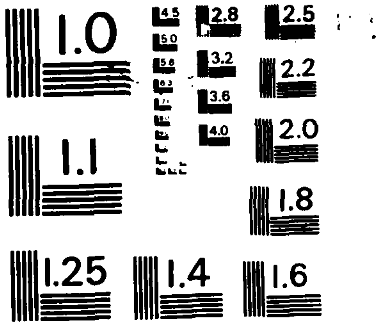

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JOINT FORWARD AREA AIR DEFENSE

TEST PROGRAM DEFINITION

OFFICE OF THE UNDERSECRETARY OF DEFENSE
FOR RESEARCH AND ENGINEERING
JOINT FORWARD AREA AIR DEFENSE TEST FORCE

FORT BLISS TEXAS 79916

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This effort was conducted by the Joint Forward Area Air Defense Test Force with support provided by the United States Army TRADOC Systems Analysis Activity (TRASANA). The analytical support from TRASANA assisted in ensuring that a valid and viable test program definition was developed, and included Army analytical concerns. The TRASANA team member provided for this effort was Major Otis B. Ferguson.

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CHAPTER 1

INTRODUCTION

1-1. Purpose.

This Test Program Definition was developed by the Joint Forward Area Air Defense (JFAAD) Test Force to provide the foundation for a detailed test design and to guide the analytical efforts of the Test Force. It was developed with the support of the TRADOC Systems Analysis Activitv (TRASANA).

1-2. Background.

a. The forward area air defense (FAAD) system supporting US ground forces has traditionally operated under restrictive visual rules of engagement. In the past, the requirements to visually identify aircraft before firing did not significantly affect air defense effectiveness as the weapons were either very limited in range (Vulcan) or lacked a forward hemisphere capability (Chaparral or Redeye). The US Army and US Marine Corps are in the process of upgrading their short range air defense (SHORAD) capability with systems that include Chaparral/FLIR, SGT York, US Roland, Vulcan/Product Improved Vulcan Air Defense System (PIVADS), Light Air Defense System (LADS), and Stinger. These systems offer the potential for a significant forward hemisphere engagement capability which could result in increased attrition of threat aircraft prior to ordnance release on defended assets. The major problem confronting the employment of these new air defense weapons systems is the establishment of conditions which allow increased air defense effectiveness without an unacceptable risk to friendly aircraft (fixed wing or rotary wing) operating over friendly forces. In December 1981, the Office of the Under Secretary of Defense for Research and Engineering (OUSDRE) chartered a Joint Test Directorate to begin investigating the problem. Known as the Joint Forward Area Air Defense Test Directorate, its purpose is to evaluate methods of improving the effectiveness of FAAD while reducing friendly air casualties from friendly fire. The JFAAD Test Force will involve air and air defense assets operating in and above the ground division area. The Test Force objectives are to measurably improve FAAD performance, measurably reduce friendly air casualties due to FAAD, and identify joint tactical, doctrinal, and procedural changes.

b. By July 1982, the JFAAD Test Program had progressed from a general concept to a more specifically defined program. During this time, a large number of proposed test issues were gathered from as many field commanders and staff as scheduling would allow, focusing on the most difficult, high-threat areas (NATO Central Region and Southwest Asia). These issues were consolidated and reduced to only those that, if resolved, will directly contribute to achieving the JFAAD objective. These test issues are:

(1) To what degree do the collective means of aircraft identification influence the effectiveness of FAAD systems?

(2) To what degree do projected C^3I capabilities support FAAD elements?

(3) How does airspace management and control affect the mission accomplishment of FAAD systems and friendly aircraft?

The test issues have been further expanded in Chapter 2 and Appendixes A, B, and C.

1-3. Definitions. Terminology used within this document is explained below to identify and clarify the context in which the terms are used.

a. Aircraft Overflight. An aircraft flight that transits through a fire unit's engagement zone, regardless of the availability of the fire unit to engage the aircraft.

b. Air Interdiction (AI). Those friendly aircraft that attack enemy target locations without relying on forward air controllers. The target location may be near the forward line of own troops (FLOT) or deeper into enemy controlled territory. The lack of control in the target vicinity distinguishes the aircraft as air interdiction rather than the distance it penetrates into enemy controlled territory.

c. Airspace Management (ASM). The effort necessary to orchestrate the employment of airspace users for the concurrent accomplishment of AirLand Battle missions. It consists of coordination, integration, regulation, and identification of the use and users of an airspace of defined dimensions. As used in the context of JFAAD, the ASM issue includes only those elements which impact the air defense mission (protection of friendly assets) and the effect air defense measures have on aircraft functioning in, or transiting through, the forward area. The capability of a forward air controller to direct aircraft to a target or the capabilities of an aircraft to locate and kill a target are outside the scope of the test. However, if the air defense measures in effect directly or indirectly affect the aircraft's capability to engage and kill targets, the impact of that ASM element will be captured and reported; i.e., aircraft delayed, target misidentified, etc.

d. Alerting. A level of targeting information that provides gross positional data on an aircraft at extended ranges. Alerting prepares the fire unit for an engagement or defensive action. Gross positional data is defined as locating the aircraft within plus or minus 15 degrees from the fire unit at a range between 10 and 30 kilometers. Alerting will include tentative identification (friend, foe, or unknown) if available. Alerting information must be updated within user specifications (presently 4 seconds) to remain current.

e. Close Air Support (CAS). Those friendly aircraft that attack enemy target locations while under the control of forward air controllers. The target location is normally near the FLOT but may be as deep into enemy controlled territory as possible for forward air controllers to direct the aircraft.

f. Command Direct. A level of targeting information that provides specific engagement instructions to a specific fire unit. Command directed information designates the specific aircraft to be engaged by the fire unit. Command direction overrides weapon control status, fire unit sectors, or any

control factor. Command directed information may be generated at any level above the fire unit and may be added to a sensor's alerting or cueing information by an intermediate command element.

g. Controlled Input Variable. A data element fixed as input to a test event. Each time the value of one or more controlled input variables is changed, the event must be rerun to determine the impact of the changes on the resulting output of the test event.

h. Cueing. A level of targeting information that provides specific and timely positional data with tentative identification of an aircraft within a designated range of a fire unit. Specific positional data is defined as locating the aircraft within plus or minus 5 degrees from the fire unit, at a range within 10 kilometers of the fire unit. Tentative identification (friend, foe, or unknown) will be provided as a part of the cueing information. Cueing information must be updated within user specifications (presently 4 seconds) to meet the requirement of timely data.

i. Data Requirement (DR). A data requirement is a discrete piece of information that can be directly collected or measured without any calculation or processing. Data requirements, and the associated data elements, are analyzed to address the test issue.

j. Detection Zone. The maximum, three-dimensional area surrounding a fire unit in which an aircraft can be detected. The detection zone is affected by terrain, aircraft altitude, visibility conditions, and fire unit capabilities.

k. Direct Identification. The identification of an aircraft by a fire unit's organic means. Direct identification may be aided by cueing or alerting, but the fire unit is responsible for making the final identification leading to the engagement decision.

l. Engagement. The process by which a fire unit tracks a target and launches a round at the aircraft. The fire unit makes an engagement decision after determining whether the aircraft is hostile (considering weapons control status and other command restrictions).

m. Engagement Opportunity. The entry of an aircraft into an engagement zone of an operational fire unit. The fire unit may or may not be available for engagement due to a number of factors (engagement in progress, weapon control status, etc.); however, an aircraft entry into the engagement zone counts as an engagement opportunity. If the fire unit is operational but moving (and unable to engage while moving) or is operational but out of ammunition, the aircraft entry into the engagement zone will not be counted as an engagement opportunity but will be counted as an aircraft overflight.

n. Engagement Zone. The maximum, three-dimensional area surrounding a fire unit in which an aircraft can be engaged. The engagement zone is affected by the surrounding terrain and aircraft maneuvering, but is not affected by gunner reaction time. Aircraft maneuvering may potentially remove the aircraft from the engagement zone at the moment of firing. Subsequent maneuvering will influence the probability of kill.

o. Event. A test situation, which utilizes controlled variables as input conditions to allow recording of specific data required for analysis.

p. Forward Area. The area extending from the division rear boundary, forward to the front line of own troops (FLOT) and beyond, as far as weapons engagement zones can reach.

q. Indirect Identification. The identification of an aircraft by a means other than the fire unit. The fire unit accepts externally generated information and uses it as a basis for an engagement decision. Indirect identification can be provided as alerting information, cueing information, or command directed information.

r. Issue. An area of concern that must be addressed to support the test and evaluation, and decision process.

s. Linkage. The set of communication nodes (i.e., stations) and the communication network used by the nodes to pass a piece of information from the information originator to the intended user. The linkage may be different for various types of information. Each potential user may have multiple, simultaneous linkages available at a given time.

t. Measures of Effectiveness (MOE). The overall standard by which the forward area air defense system performance is measured. A measure of effectiveness is the highest level question to be answered for each issue system and compared for each issue.

u. Measure of Performance (MOP). An intermediate standard that serves as a component of a higher level measure of effectiveness. A measure of performance is resolved by analyzing data requirements or subordinate measures of performance.

v. Multiple Pass Aircraft. An aircraft that enters the detection zone of a fire unit and makes more than one pass on a target(s). Either the target, its ordnance release point, or both are located within the engagement zone of the fire unit.

w. Output Variable. A data element generated as output from a test event. Output variables must be carefully measured, as the processing of the test event influences the resulting values.

x. Perception. The act of apprehending by means of the senses or the mind. Intuitive recognition.

y. Single Pass Aircraft. An aircraft that enters and exits the detection or engagement zone of a fire unit and makes a pass on a target(s). Those aircraft that overfly the coverage zone of a fire unit and do not release ordnance will be designated as transiting aircraft.

z. System. The set of tactics, techniques, procedures, or equipment that subdivide the issue into major, independent frameworks. Each issue contains multiple systems, each of which will be evaluated separately in terms of the MOEs, MOPs, and DRs. The comparison of system results will form the basis for the issue resolution.

aa. Target Information. The alerting or cueing information available within the command and control system for dissemination to the FAAD units. The targeting information is considered in the C^2 system when first detected by a sensor, whether or not the information has been received by a fire unit(s).

CHAPTER 2

JFAAD TEST METHODOLOGY

2-1. Overview. The JFAAD Test Program Definition was developed using nine distinct steps, shown in Figure 2-1. This development reflects the JFAAD staff's determination to develop a clearly defined, complete, and thorough test program. The first four steps, from problem identification through statement of the test issues, are addressed in Chapter 1. Once these steps were finalized, they provided the foundation upon which a detailed test definition could begin. The last five steps, also shown in Figure 2-1, were undertaken to: (a) identify all data required to accomplish the test, (b) present the interrelationships of the data, (c) identify all test events that must occur to produce the required data, and (d) investigate the best methods to generate the required events. The remainder of this document focuses on the development of the detailed test definition, from Measures of Effectiveness through a Preliminary Assessment of Analytical Tools.

a. Test Issues and Systems. Each of the three issues is described below. The issues are not totally independent; in fact, an interaction between issues is expected and will be thoroughly examined in the analysis.

(1) The first issue is to analyze how the collective means of aircraft identification influence the effectiveness of forward area air defense systems. The issue will be resolved by investigation and statistical analysis of two major systems, which bound the term "means of aircraft identification" and testing for interactions with the alternative systems of the other issues.

(a) The first system is direct identification. Visual and electronic identification friend or foe (IFF) are the current means of direct identification as defined by JFAAD. Current doctrine requires direct identification as defined above for positive identification, but JFAAD will analyze a second system-indirect identification-as a possible way of influencing new doctrine.

(b) The second system, indirect identification, is provided by information received through the communication system from other elements. Under favorable conditions, the fire unit receives information concerning aircraft position and identification before the aircraft enters the detection range of the fire unit, and this information is intended to aid in earlier target detection. Once detected, under current doctrine, the aircraft must still be identified by direct means. In this context, the major system of indirect identification is a doctrinal excursion for JFAAD, because the analysis of this category will be conducted as if the fire unit were allowed the freedom to engage upon receipt of hostile aircraft information without requiring direct verification.

(2) The second issue will examine how C^3I architectures influence the effectiveness of FAAD systems. The issue is divided into three major systems to bound the term "SHORAD C^3I networks" to be investigated by JFAAD, along with possible interactions with other issue systems.

PROBLEM

CURRENTLY JOINT TACTICS AND PROCEDURES FOR SHORAD DO NOT PERMIT EMPLOYMENT OF FAAD ASSETS TO THE FULL EXTENT OF THEIR CAPABILITIES WITHOUT ADVERSELY AFFECTING EMPLOYMENT OF FRIENDLY AIRCRAFT.

PURPOSE

TO IMPROVE EFFECTIVENESS OF SHORAD ASSETS AND REDUCE FRIENDLY AIR CASUALTIES FROM FRIENDLY FIRE.

OBJECTIVES

TO PROVIDE MEASURABLE IMPROVED FAAD PERFORMANCE.
TO REDUCE FRIENDLY AIRCRAFT KILLED.
TO IDENTIFY JOINT TACTICAL, DOCTRINAL, AND PROCEDURAL CHANGE

ISSUES

AIRCRAFT ID, PROJECTED C^3I, AIRSPACE MANAGEMENT.

MEASURES OF EFFECTIVENESS

PERCENT HOSTILE AIRCRAFT KILL.
PERCENT FRIENDLY AIRCRAFT KILL.

ANALYSIS PLAN

PATTERN OF ANALYSIS

DEVELOP AUDIT TRAIL FROM MEASURES OF EFFECTIVENESS THROUGH THE MEASURES OF PERFORMANCE TO THE DATA REQUIREMENTS (FOR EACH ISSUE).

DATA HANDLING

DEFINES THE STATISTICAL AND INVESTIGATIVE METHODOLOGY FOR ANSWERING THE MEASURES OF EFFECTIVENESS, COMPARISON OF THE ALTERNATIVE SYSTEMS FOR THE THREE ISSUES STATISTICALLY, AND EXAMINATION OF INTERACTIONS BETWEEN SYSTEMS TO RESOLVE THE ISSUES.

ROSTER OF REQUIRED EVENTS

IDENTIFIES TEST EVENTS TO GENERATE ALL DATA REQUIREMENTS.

PRELIMINARY ASSESSMENT OF ANALYTICAL TOOLS

IDENTIFIES PREFERRED TOOL OR TOOLS TO COLLECT DATA REQUIREMENTS FROM EACH EVENT.

Figure 2-1. Steps Undertaken in Development of the JFAAD Test Program Definition.

(a) The first system is the Enhanced Manual SHORAD Control System (EMSCS). EMSCS serves as an analytical baseline, because it is the SHORAD architecture which will be fielded in 1986 regardless of ongoing efforts by the Project Manager, Air Defense Command and Control (PM ADCC). EMSCS incorporates the expanded Air Battle Management Operations Center (ABMOC) at the SHORAD battalion, and correlates inputs from all available sensors. The fire units receive information from the ABMOC via improved AM-FM automatic retransmission, but do not receive alerting data directly from the sensors.

(b) The second major system is the Objective SHORAD Command and Control System, which incorporates significant changes over the EMSCS. The Objective System adds the Joint Tactical Interface Display System (JTIDS) to the Position Location Reporting System (PLRS) network incorporating the PLRS/JTIDS Hybrid (PJH) technology, providing automation of data transmission to the SHORAD fire units.

(c) The third C^3I system is for excursion investigations. This system will consist of networks and/or equipment unique from any other system in existence and will be developed by the JFAAD Test Force. By providing an excursion system, JFAAD will have the capability to test future C^3I systems as they are developed and determine their affect on overall SHORAD performance.

(3) The third issue is to analyze how forward area airspace management procedures affect mission accomplishment of FAAD systems and friendly aircraft. The issue is divided into three major systems to restrict the airspace management and control measures influencing forward area operations. The major systems of airspace management represent distinct sets of procedures and restrictions which, although currently associated with a geographical area, will be evaluated as a set of procedures across all JFAAD scenarios.

(a) The first system deals with the Central Region Airspace Control Plan, which is currently in effect for US forces in Central Europe. The Central Region Airspace Control Plan establishes a geographic grid of points which can be connected to designate inbound and outbound aircraft corridors. Provisions for the use of free fire zones and restricted fly zones are included in the plan.

(b) The second system is associated with a plan, adopted by the Rapid Deployment Force and being considered by NATO, called the Minimum Risk Passage in Air Defense. The Minimum Risk Passage procedures establish control of aircraft by limiting the number of friendly aircraft returning together and setting minimum return altitudes to avoid SHORAD engagement zones.

(c) The third system of airspace management procedures is for excursion investigations. The system will consist of a set of measures and procedures that are unique from any single plan or system in existence and will be developed by JFAAD.

Figure 2-2 identifies the test relationships between the mission, issues, and systems.

MISSION	ISSUES	SYSTEMS
Improve effectiveness of SHORAD assets and reduce friendly air casualties from friendly fire. Identify system combination with the highest percent of hostile kills and the least percent of friendly kills.	Aircraft Identification (1.0)	Direct (1.1)
		Indirect (1.2)
	Projected C^3I Capabilities (2.0)	Enhanced Manual SHORAD Control System (2.1)
		Objective SHORAD C^2 System (2.2)
		Excursion SHORAD C^3I System (2.3)
	Airspace Management (3.0)	Central Region Airspace Control Plan (3.1)
		Minimum Risk Passage in Air Defense (3.2)
		Excursion ASM System (3.3)

Figure 2-2. JFAAD Test Dendrite.

b. Measures of Effectiveness.

(1) MOEs directly relate to JFAAD's stated purpose of improving FAAD performance and reducing fratricide. Put in measurable form, these standards translate into the percent of hostile aircraft killed and the percent of friendly aircraft killed. Each of the MOEs will be applied to each combination of Identification, C^3I, and Airspace Management systems being evaluated.

(2) Statistical methodology has been developed by which the test issues, in terms of the systems and MOEs, will be analyzed. An analysis of variance (ANOVA) or other suitable multidimensional statistical technique will be used to investigate the two identification systems, three C^3I systems, and three airspace management systems for hostile kills. A similar analysis will be repeated for friendly kills. Interactions between systems and results of the investigation made at the MOP and DR level will also be presented for consideration in determining which combination of identification, C^3I, and airspace management procedures maximizes the effectiveness of FAAD elements and minimizes friendly air casualties due to FAAD. The anticipated anlysis table is shown in Table 2-1.

(3) JFAAD's MOEs provide the focal point below which the Analysis Plan (consisting of the Pattern of Analysis and the Data Handling), Roster of Required Events, and Preliminary Assessment of Analytical Tools were developed.

c. Pattern of Analysis (Appendix A, B, and C). The pattern of analysis presents an audit trail from each issue system, to the MOEs, through the intermediate MOPs, to the detailed DRs. An independent pattern of analysis has been developed for each test issue and is presented in dendritic format to delineate the relationships between levels of the analysis framework. Indicated on the dendrites are numbers and keywords that describe the major area or concern for each level, and can be traced to the pattern of analysis from a test issue to the DRs as follows:

(1) The MOE or MOP question. This element states the major question to be answered at the specific level of the analytical structure.

(2) The data inputs needed to answer the MOE or MOP question. Data inputs are the next subordinate level MOP or the DRs which must be analyzed to provide the answer to the specified MOE or MOP question.

d. Data Handling (Appendix A, B, and C). The data handling section defines the statistical methodology by which each intermediate MOP will be analyzed prior to development of the next higher level of MOP or to the MOE, described below.

(1) The statistical methodology describes how the data inputs are to be treated to answer the MOE or MOP question.

(2) The data presentation method is the type of display to be used for the data inputs and MOE/MOP question. If the presentation is in tabular form, the planned format of the table is provided. Tables generated

Table 2-1. JFAAD Issue Analysis.

C^3I	ENHANCED MANUAL SHORAD CONTROL SYSTEM		OBJECTIVE SHORAD C^2 SYSTEM		EXCURSION SHORAD C^3I SYSTEM	
ID ASM	DIRECT	INDIRECT	DIRECT	INDIRECT	DIRECT	INDIRECT
CENTRAL REGION PLAN						
MINIMUM RISK PLAN						
EXCURSION ASM PLAN						

NOTE: Percent of hostile aircraft killed and percent of friendly aircraft killed will be presented on the table for analysis of the alternative systems within the three issues. Additionally, interactions between the systems and results of any detailed analyses performed will be presented with the table.

will reflect the performance of a particular method or procedure within a specified issue system. Similar tables will be developed for the other methods or procedures under each system of the specified issue.

e. Roster of Required Events (RRE) (Chapter 3). The RRE identify those test events that must occur to ensure generation of all data required for each test issue. For each event, a set of controlled, input variables have been defined to establish the criteria for conducting an event. A set of output variables have also been identified to define the data required from each event. Each of the required events may include DRs from each test issue, thereby linking all test issues and allowing a single scenario to be conducted.

f. Assessment of Analytical Tools (Chapter 4). The assessment of analytical tools provides a preliminary determination of the appropriateness of various analytical tools for the execution of, and the data collection from, the test events. Each event is discussed in terms of the relative degree of accuracy achieved when conducted as a field test, a manned simulator event, or a computer model run.

g. Data Results. The individual results represented by a single data table are not to be used to describe the absolute performance of a system or procedure. JFAAD will report on the relative difference in the performance between systems or procedures by comparing results in the appropriate data tables. The relative difference in results provides the perspective that applies throughout the analysis plan: data are generated to the degree that will allow uniform, consistent comparison of results given minor changes in controlled input variables, rather than generating data to the degree satisfactory for detailed engineering analysis of a particular system. Additionally, the number of iterations performed during a test must be sufficient to provide confidence in the data collected.

2-2. Issue 1: Identification. Appendix A presents the analysis plan which includes the pattern of analysis and data handling for the identification issue. The analysis plan provides development of the analysis methodology for one critical path of the pattern of analysis. Similar methodologies will be performed for the remaining paths. The statistical techniques identified in this document should be considered representative of the types of comparisons needed for answering an MOP/MOE. The exact technique actually used will be highly dependent upon the ability of the data to meet the underlying assumptions associated with the particular statistical test.

a. Pattern of Analysis. See pages A-1 thru A-9.

b. Data Handling. See pages A-10 thru A-17.

2-3. Issue 2: C^3I. The analysis plan for the C^3I issue is presented in Appendix B. Again, the analysis plan only provides development of one critical path. Similar methodologies will be performed for remaining paths.

a. Pattern of Analysis. See pages B-1 thru B-14.

b. Data Handling. See pages B-15 thru B-25.

2-4. Issue 3: Airspace Management. The airspace management analysis plan is presented in Appendix C. The analysis plan also develops the analysis methodology for one critical path. As with the previous two issues, similar methodologies will be performed for the remaining paths.

a. Pattern of Analysis. See pages C-1 thru C-13.

b. Data Handling. See pages C-14 thru C-22.

2-5. Analysis Example. An example of the implementation of an analysis of test results is presented in Appendix D. The direct identification system was chosen for simplicity and for a more comprehensive understanding by the reader. The analysis path is highlighted in the pattern of analysis, and the appropriate tables from the data handling section are shown. The data contained in the tables are fictitious.

CHAPTER 3

ROSTER OF REQUIRED EVENTS

3-1. Introduction. The roster of required events is identified in the successive sections of this chapter. These are events that must occur to generate the data requirements for each test issue. A single event will capture data for all three test issues. Additionally, although test events are independent, they can be run sequentially and/or simultaneously to conserve resources.

3-2. Event 1. A fire unit's engagement zone is entered by transiting aircraft.

a. Controlled Input Variables:

(1) Aircraft parameters-identification, category, type (Issues 1, 2, and 3)

(2) Flight parameters-speed, heading, location (Issues 1, 2, and 3)

(3) Fire unit parameters-type, sector limits, location (Issues 1, 2, and 3); weapon control status, movement times, ammunition status (Issue 2)

(4) Message parameters-alerting, cueing, and command directed information at the fire unit (Issues 1 and 2); other C^3I information at the fire unit (Issue 2)

(5) Means of identification-visual, electronic, visual and electronic, cue, alert, command directed (Issue 1)

(6) Meteorological visibility range (Issue 1)

(7) ASM measure parameters-type, boundaries, allowed heading, speed, effective time (Issue 3)

(8) Enter and exit detection zone-location, time (Issues 1 and 2)

(9) Enter and exit engagement zone-location, time (Issues 1, 2, and 3)

b. Output Variables:

(1) Engagement sequence-detection range, identification range, engagement range, kill range, times (Issues 1, 2, and 3)

(2) Identification decision, reason, and accuracy (Issues 1, 2, and 3)

(3) Accuracy of perception of aircraft category (rotary, fixed wing, etc.) (Issues 1, 2, and 3)

(4) Accuracy of perception of aircraft location (Issue 2)

(5) Accuracy of perception of aircraft attack profile (transiting or attacking) (Issue 2)

(6) Accuracy of perception of aircraft compliance with the airspace management measure (Issue 3)

(7) Accuracy of perception of airspace management measure (Issues 2 and 3)

3-3. Event 2. A fire unit's engagement zone is entered by aircraft making single attack passes.

a. Controlled Input Variables:

(1) Aircraft parameters-identification, category, type (Issues 1, 2, and 3)

(2) Flight parameters-speed, heading, location (Issues 1, 2, and 3)

(3) Fire unit parameters-type, sector limits, location (Issues 1, 2, and 3); weapon control status, movement times, ammunition status (Issue 2)

(4) Message parameters-alerting, cueing, and command directed information at the fire unit (Issues 1 and 2); other C^3I information at the fire unit (Issue 2)

(5) Means of identification-visual, electronic, visual and electronic, cue, alert, command directed (Issue 1)

(6) Meteorological visibility range (Issue 1)

(7) ASM measure parameters-type, boundaries, allowed heading, speed, effective time (Issue 3)

(8) Enter and exit detection zone-location, time (Issues 1 and 2)

(9) Enter and exit engagement zone-location, time (Issues 1, 2, and 3)

b. Output Variables:

(1) Engagement sequence-detection range, identification range, engagement range, kill range, times (Issues 1, 2, and 3)

(2) Time of ordnance delivery (Issue 1)

(3) Identification decision, reason and accuracy (Issues 1, 2, and 3)

(4) Accuracy of perception of aircraft category (rotary, fixed wing, etc.)(Issues 1, 2, and 3)

(5) Accuracy of perception of aircraft location (Issue 2)

(6) Accuracy of perception of aircraft attack profile (transiting or attacking)(Issue 2)

(7) Accuracy of perception of aircraft compliance with the airspace management measure (Issue 3)

(8) Accuracy of perception of airspace management measures (Issues 2 and 3)

3-4. <u>Event 3</u>. A fire unit's engagement zone is entered by aircraft making multiple attack passes.

a. Controlled Input Variables:

(1) Aircraft parameters-identification, category, type (Issues 1, 2, and 3)

(2) Flight parameters-speed, heading, location (Issues 1, 2, and 3)

(3) Fire unit parametes-type, sector limits, location, (Issues 1, 2, and 3); weapon control status, movement times, ammunition status (Issue 2)

(4) Message parameters-alerting, cueing, and command directed information at the fire unit (Issues 1 and 2); other C^3I information at the fire unit (Issue 2)

(5) Means of identification-visual, electronic, visual and electronic, cue, alert, command directed (Issue 1)

(6) Meteorological visibility range (Issue 1)

(7) ASM measure parameters-type, boundaries, allowed heading, speed, effective time (Issue 3)

(8) Enter and exit detection zone-location, time (Issues 1 and 2)

(9) Enter and exit engagement zone-location, time (Issues 1, 2, and 3)

b. Output Variables:

(1) Engagement sequence-detection range, identification range, engagement range, kill range, times (Issues 1, 2, and 3)

(2) Time of ordnance delivery for each pass (Issue 1)

(3) Identification decision, reason, and accuracy (Issues 1, 2, and 3); maintenance of identification tag on each pass (Issue 1)

(4) Accuracy of perception of aircraft category (rotary, fixed wing, etc.)(Issues 1, 2, and 3)

(5) Accuracy of perception of aircraft location (Issue 2)

(6) Accuracy of perception of aircraft attack profile (transiting or attacking)(Issue 2)

(7) Accuracy of perception of aircraft compliance with the airspace management measure (Issue 3)

(8) Accuracy of perception of airspace management measure (Issues 2 and 3)

3-5. <u>Event 4</u>. The detection envelope of an operational sensor in a C^3I network is entered by aircraft.

a. Controlled Input Variables:

(1) Aircraft parameters-identification, category, type (Issues 1, 2, and 3)

(2) Flight parameters-speed, heading, location (Issues 1, 2, and 3)

(3) Sensor parameters-type, sector limits, location (Issue 2)

(4) Enter and exit detection zone-location, time (Issue 2)

b. Output Variables:

(1) Sensor sequence-detection range, identification range, times (Issue 2)

(2) Accuracy of perception of aircraft identification (Issue 2)

(3) Accuracy of perception of aircraft category (Issue 2)

(4) Accuracy of perception of aircraft location (Issue 2)

3-6. Event 5. A communication node generates and transmits a message over a specified net linkage.

a. Controlled Input Variables:

(1) Net parameters-identification (Issue 2)

(2) Message parameters-type, precedence (Issue 2)

(3) Originator parameters-identification (Issue 2)

(4) Addressee parameters-identification (Issue 2)

b. Output Variables:

(1) Originator sequence-processing time, time transmission began, message contents transmitted, time transmission ended (Issue 2)

(2) Receiver identification (Issue 2)

3-7. Event 6. A communication node receives and relays or retransmits a message over a specified net linkage.

a. Controlled Input Variables:

(1) Net parameters-identification (Issue 2)

(2) Message parameters-type, precedence, time of receipt (Issue 2)

(3) Intermediate node parameters-identification (Issue 2)

(4) Addressee parameters-identification (Issue 2)

b. Output Variables:

(1) Intermediate node sequence-processing time, perceived message contents, time transmission began, message contents transmitted, time transmission ended (Issue 2)

(2) Receiver identification (Issue 2)

3-8. Event 7. A communication node receives a message over a specified net linkage and takes action on the message received.

a. Controlled Input Variables:

(1) Net parameters-identification (Issue 2)

(2) Message parameters-type, precedence, time of receipt (Issue 2)

(3) User parameters-identification (Issue 2)

b. Output Variables:

(1) User sequence-perceived message contents (Issue 2)

(2) Action required (Issue 2)

3-9. Event 8. Friendly aircraft receive a request for support and attempt to provide the requested support.

a. Controlled Input Variables:

(1) Aircraft parameters-category, type, mission (Issue 3)

(2) Flight parameters-speed, heading, location (Issue 3)

(3) Target parameters-identification, location, requested time-on-target, not-later-than time-on-target (Issue 3)

(4) Fire unit parameters-type, sector limits, location (Issue 3)

(5) ASM measure parameters-type, boundaries, allowed heading, speed, effective time (Issue 3)

b. Output Variables:

(1) Event sequence-initiate support attempt, fratricide, support primary target, support alternate target (Issue 3)

(2) Lost opportunity due to ASM (target has moved by the time the aircraft reaches the target area)(Issue 3)

(3) Primary target not reached due to ASM (Issue 3)

CHAPTER 4

PRELIMINARY ASSESSMENT OF ANALYTICAL TOOLS

4-1. Introduction. The roster of required events provides a series of events that will generate data supporting a JFAAD test issue. The JFAAD Test Force anticipates three primary methods of obtaining the data required: (a) small-scale field tests and piggy-back exercises, (b) simulators, and (c) computer modeling techniques. A survey of analytical tools has been performed and results incorporated in a series of publications presented in the reference list. The JFAAD test methodology is anticipated to make maximum use of computer modeling and manned simulation. Small field exercises, as well as individual and group testing, can be used to supplement and validate data obtained through simulation. The set of evaluation tools will be used interactively to reduce the cost/risk associated with large scale field tests. However, a large scale field test will still be required to validate new doctrinal and procedural concepts developed by JFAAD. Other techniques capable of generating data in sufficient detail to satisfy JFAAD's analysis requirements will also be considered. The following are JFAAD's preliminary assessment of analytical tools:

a. Events 1, 2, 3, and 4. These events will generate data required for all three issues. Data produced by these events will help determine the capability of a fire unit to detect, identify, engage, and kill aircraft. A simulator or a field exercise can be used to gather data for these events. Accuracy of the data will be required in sufficient detail to assess the relative impact that each of the controlled independent variables has on the dependent variable.

b. Events 5, 6, and 7. These events generate data required to analyze the effectiveness of a communication linkage system. Data produced by these events will help determine the processing time to generate messages, time to transmit the message to addressees, types of messages sent over a communication linkage, and quality of the information received. A simulator or field exercise can be used to gather baseline data. Accuracy of the data will be necessary in sufficient detail to measure when queueing situations exist and when incomplete or inaccurate messages are received.

c. Event 8. This event generates data required to analyze the mission accomplishment of friendly air support. Data produced by this event will be required in sufficient detail to follow an aircraft through the division area and measure the aircraft's capability to complete the assigned air support mission. A simulator, computer model, or field exercise can be used to gather the data.

4-2. Analytical Tool Relationships. Although construction of functions and logic from test events 1 through 8 will be necessary before a computer simulation program can be developed, it is anticipated that a computer simulation can be used to generate data provided by the integration of all eight events. Construction of the model will require sufficient accuracy t assure that the relative difference in the performance among various systems or procedures will allow the decision maker to make the same decision as he

would make from experimentation using the actual system. Thus, in addition to a computer simulation, field exercises conducted in a realistic battle environment can also produce the data required to accomplish the required analyses.

CHAPTER 5

TEST CONDITIONS

5-1. Introduction.

The events included in the roster of required events must be repeated for each set of scenario test conditions to determine the dependency of the results on the scenario. The preliminary identification of variable categories that comprise the test conditions are briefly described below and will be further expanded and refined as the scenario definitions are completed. With the completion of scenario definitions the number of sets of variable categories will be refined as the test scope is finalized.

5-2. Scenario Location.

a. Europe. The scenario will focus on one of the US divisions in the 5th or 7th US Corps. The division will be organized in accordance with the projected 1986 force structure. If there is a need to analyze a division along the northern European flank, that scenario will be evaluated separately and will expand the scope of the test by adding a scenario location category.

b. Southwest Asia. The scenario will focus on one of the US divisions with a contingency mission for Southwest Asia. The division will be organized in accordance with the projected 1986 force structure for the mission.

5-3. Air Environment.

a. Air Operation Phase. The threat aircraft entering the division airspace during D-Day raids will be examined. The numbers and types of aircraft will be specified by 1992 threat documents. The air operations phase is characterized by a level of intense air activity with the majority of enemy aircraft targeted against nondivisional assets. The friendly aircraft activity during this phase is structured to counter the threat with the majority of the aircraft being used in an air defense mission.

b. Post-Air Operation Phase. The threat aircraft entering the division airspace after the intense D-Day raids will be examined. The numbers and types of aircraft will be specified by 1992 threat documents. During the steady state post-air operations phase air battle, most of the enemy aircraft will attack targets within the division sector. The friendly aircraft activity during this phase is structured to counter the threat with the majority of the fixed wing, multiple capability aircraft being used in close air support or battle area interdiction missions.

5-4. Electronic Warfare Environment.

a. Benign. Test cases will be examined without electronic warfare. The effect on the battle outcome without electronic warfare will be analyzed. The benign environment provides the base case for field test validation and allows analysis of the effects of electronic warfare.

b. Electronic Warfare Conditions. Scenarios will be evaluated where communications and sensor capabilities are influenced by electronic warfare. yhe electronic countermeasures used will be consistent with the capabilities of the 1992 threat and the potential of the 1986 force structures to counter the threat.

5-5. Visibility Conditions.

a. Clear Day. Optimal atmospheric condition parameters will be established for each scenario location. An assessment of the likelihood of encountering these conditions based on past averages will be developed. Of primary importance are weather parameters that impact on the engagement sequence, as well as those weather parameters that impact on aircraft support and threat aircraft activity.

b. Obscured Visibility. Below optimal atmospheric condition parameters will be established for each scenario location. Again, an assessment of the likelihood of encountering these conditions based on past averages will be developed. Of primary importance are weather parameters impacting on the engagement sequence, aircraft support, and threat aircraft activity.

c. Night. Night weather condition parameters will be established for each scenario location. An assessment, based on averages, will be made over all moonlight and haze conditions. Of primary importance are weather parameters impacting on the engagement sequence, aircraft support, and threat aircraft activity.

CHAPTER 6

ACRONYM LIST

ABMOC	Air Battle Management Operations Center
ADCC	Air Defense Command and Control
AI	air interdiction
AM	amplitude modulation
ANOVA	analysis of variance
ASM	airspace management
ASTARS	Airborne SHORAD Target Acquisition Radar System
AWACS	Airborne Warning and Control System
C^2	command and control
C^3I	command, control, communications, and intelligence
CAS	close air support
DDT&E	Director, Defense Test and Evaluation
DR	data requirement
DTG	date-time group
FAAD	forward area air defense
FAAR	forward area alerting radar
FLIR	forward looking infrared
FLOT	forward line of own troops
FM	frequency modulation
ID	identification
ICC	Information Coordination Central
JFAAD	Joint Forward Area Air Defense
JTIDS	Joint Tactical Interface Distribution System
LADS	Light Air Defense System
MOE	measure of effectiveness
MOP	measure of performance
NATO	North Atlantic Treaty Organization
OUSDRE	Office of the Under Secretary of Defense for Research and Engineering
PJH	PLRS/JTIDS Hybrid
PLRS	Position Location Reporting System
PM	program manager
RRE	roster of required events
SHORAD	short range air defense

ACRONYM LIST (Cont.)

TOT	time on target
TPD	test program definition
TRADOC	Training and Doctrine Command
TRASANA	TRADOC Systems Analysis Activity

CHAPTER 7

REFERENCE LIST

Anonymous, "Test Officer's Planning Manual," Memorandum 71-1, TRADOC Combined Arms Activity, Fort Hood, Texas, 26 November 1979.

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Anonymous, "Field Environmental Simulator Feasibility Report," Technical Memorandum, OTEA, Falls Church, VA 22041, 1 June 1982.

Dolan, Major Kevin, "Model Logic and Data Requirements," Technical Memorandum, JFAAD, Fort Bliss, TX 79906, 26 July 1983.

Ferguson, Major Otis B., "Joint Forward Area Air Defense Model Requirements," TRASANA-38-83, TRASANA, White Sands Missile Range, NM 88002, September 1983.

APPENDIX A

ISSUE 1: IDENTIFICATION (ID)

ANALYSIS PLAN

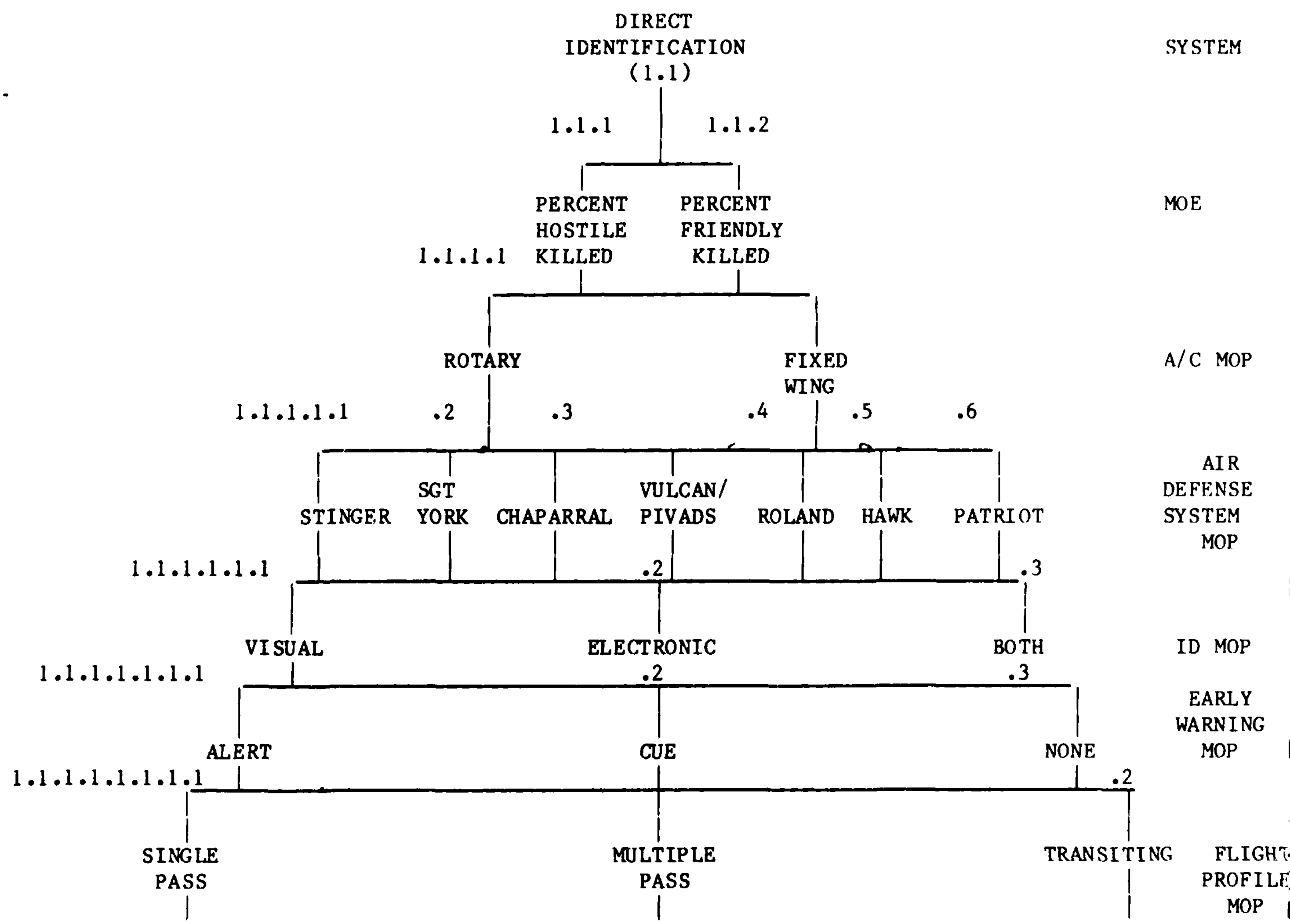


Figure A-1. Pattern of Analysis for Direct Identification System.

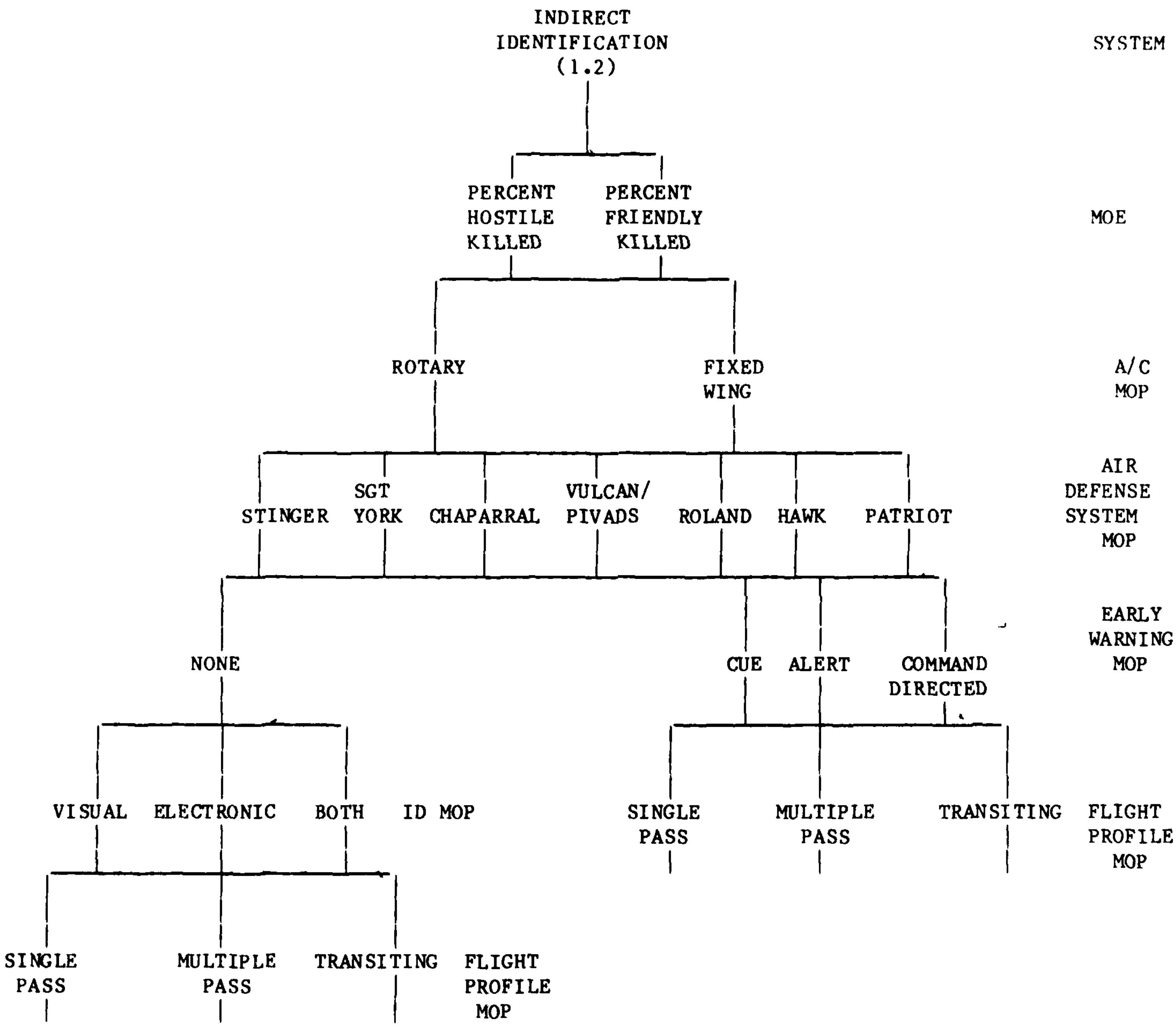


Figure A-2. Pattern of Analysis for Indirect Identification System.

- 1.1.1.1.1.1.1.1.1 SINGLE PASS/ MULTIPLE PASS
  - 1.1.1.1.1.1.1.1.1.1 TARGET
    - a LOCATION XYZ
    - b PASS
      - (1) PASS NUMBER
      - (2) ORDNANCE REL. TIME
  - .2 AIRCRAFT
    - a ID
    - b CATEGORY
    - c TAG
    - d TYPE
  - .3 FIRE UNIT
    - a WPN CTL STATUS
    - b TYPE
    - c TAG
    - d LEFT SECTOR
    - e RIGHT SECTOR
    - f LOCATION XYZ
  - .4 MESSAGE
    - a TYPE
    - b TAG
    - c TIME RCVD
    - d ID RCVD
    - e CATEGORY RCVD
  - .5 EVENTS
    - a ENTER DETECT
    - b DETECT
    - c ENTER ENGAGE
    - d ENGAGE
    - e KILL
    - f EXIT ENGAGE
    - g EXIT DETECT
      - (1) LOCATION
        - (a) AZIMUTH
          - 1 AIRCRAFT XYZ
          - 2 FIRE UNIT XYZ
        - (b) RANGE
          - 1 AIRCRAFT XYZ
          - 2 FIRE UNIT XYZ
        - (c) ASPECT
          - 1 HEADING
          - 2 BANK ANGLE
          - 3 AIRCRAFT XYZ
          - 4 FIRE UNIT XYZ
      - (2) TIME
      - (3) AIRCRAFT SPEED
    - h IDENTIFY
      - (1) LOCATION
        - (a) AZIMUTH
          - 1 AIRCRAFT XYZ
          - 2 FIRE UNIT XYZ
        - (b) RANGE
          - 1 AIRCRAFT XYZ
          - 2 FIRE UNIT XYZ
        - (c) ASPECT
          - 1 HEADING
          - 2 BANK ANGLE
          - 3 AIRCRAFT XYZ
          - 4 FIRE UNIT XYZ
      - (2) TIME
      - (3) AIRCRAFT SPEED
      - (4) MET VIS. RANGE
      - (5) PERCEIVED ID
        - (a) ID
        - (b) NEWLY DET
        - (c) PREV DET
      - (6) PERCEIVED CAT
      - (7) ID MEANS
        - (a) VISUAL
          - 1 UNAIDED
          - 2 BINOCULARS
          - 3 FLIR
          - 4 NOD
          - 5 OTHER
        - (b) ELECTRONIC
        - (c) BOTH
        - (d) ALERTING
        - (e) CUEING
        - (f) CMD DIR
      - (8) ID REASON
        - (a) HOSTILE ACT
        - (b) HOSTILE CRIT
        - (c) VIS. RECOG
        - (d) ASM
        - (e) ALERTING
        - (f) CUEING
        - (g) CMD DIR
        - (h) OTHER

Figure A-3. Data Requirements for Identification Issue.

PATTERN OF ANALYSIS

1. To what degree do the collective means of aircraft identification influence the effectiveness of forward area air defense (FAAD) systems? (Issue)

1.1 What was the impact of direct aircraft identification procedures on the effectiveness of FAAD systems? (System)

1.1.1 What was the percent of hostile aircraft killed? (MOE)

1.1.1.1 What was the number of hostile rotary wing aircraft engaged and killed? (MOP)

1.1.1.1.1 What was the number of hostile rotary wing aircraft engaged and killed by Stinger, given engagement opportunities? (MOP)

1.1.1.1.1.1. What was the impact of visual identification means on the Stinger contribution to the number of hostile rotary wing aircraft killed? (MOP)

1.1.1.1.1.1.1 To what degree did alerting information contribute to the impact of visual identification? (MOP)

1.1.1.1.1.1.1.1 What was the impact of hostile rotary wing aircraft making a single pass with respect to the weapon system position? (MOP)

1.1.1.1.1.1.1.1.1 What was the targeting information influencing the identification process?

a. What was the target location in X, Y, and Z? (DR)

b. What was the targeting information regarding the specific aircraft pass?

(1) What was the number of the pass at the target location? (DR)

(2) What was the date-time group (DTG) of ordnance release on this pass? (DR)

1.1.1.1.1.1.1.1.2 What was the aircraft information influencing the identification process?

a. What was the aircraft identification? (DR)

b. What was the aircraft category? (DR)

c. What was the aircraft tag? (DR)

d. What was the aircraft type? (DR)

1.1.1.1.1.1.1.1.1.3 What was the fire unit information influencing the identification process?

a. What was the weapon control status at the fire unit? (DR)

b. What was the fire unit type? (DR)

c. What was the fire unit tag? (DR)

d. What was the fire unit's left sector limit in degrees (magnetic)? (DR)

e. What was the fire unit's right sector limit in degrees (magnetic)? (DR)

f. What was the fire unit's location in X, Y, and Z? (DR)

1.1.1.1.1.1.1.1.1.4 What was the message information influencing the identification process?

a. What was the message type? (DR)

b. What was the message tag? (DR)

c. What was the DTG message received at the fire unit? (DR)

d. What was the aircraft identification received by the fire unit? (DR)

e. What was the aircraft category received by the fire unit? (DR)

1.1.1.1.1.1.1.1.1.5 What was the event information influencing the identification process?

a. What were the information elements when the aircraft entered the fire unit's detection zone?

(1) What was the location information when the aircraft entered the fire unit's detection zone?

(a) What was the azimuth from the fire unit to the aircraft when the aircraft entered the fire unit's detection zone?

1. What was the aircraft location in X, Y, and Z? (DR)

2. What was the fire unit location in X, Y, and Z? (DR)

(b) What was the range from the fire unit to the aircraft when the aircraft entered the fire unit's detection zone?

1. What was the aircraft location in X, Y, and Z? (DR)

2 What was the fire unit location in X, Y, and Z? (DR)

(c) What was the aircraft aspect when the aircraft entered the fire unit's detection zone?

1 What was the aircraft heading? (DR)

2 What was the aircraft bank angle? (DR)

3 What was the aircraft location in X, Y, and Z? (DR)

4 What was the fire unit location in X, Y, and Z? (DR)

(2) What was the DTG the aircraft entered the fire unit's detection zone? (DR)

(3) What was the aircraft's ground speed when the aircraft entered the fire unit's detection zone? (DR)

b. What were the information elements when the aircraft was detected by the fire unit?

c. What were the information elements when the aircraft entered the fire unit's engagement zone?

d. What were the information elements when the aircraft was engaged by the fire unit?

e. What were the information elements when the aircraft was killed by the fire unit?

f. What were the information elements when the aircraft exited the fire unit's engagement zone?

g. What were the information elements when the aircraft exited the fire unit's detection zone?

1.1.1.1.1.1.1.1.5.b thru g -Same as a(1) thru (3).

h. What were the information elements when the aircraft was identified by the fire unit?

(1) thru (3) Same as 1.1.1.1.1.1.1.1.5a(1) thru (3).

(4) What was the meteorological visibility range when the aircraft was identified by the fire unit? (DR)

(5) What was the fire unit's perception of the aircraft identification?

(a) What was the aircraft identification determined by the fire unit? (DR)

(b) Did the fire unit determine the aircraft was newly detected? (DR)

(c) Did the fire unit determine the aircraft was a previous detection? (DR)

(6) What was the fire unit's perception of the aircraft category? (DR)

(7) What was the means of identification used by the fire unit?

(a) Was visual identification used by the fire unit?

1 Was visual identification unaided? (DR)

2 Was visual identification aided by binoculars? (DR)

3 Was visual identification aided by forward looking infrared (FLIR)?

4 Was visual identification aided by a night observation device? (DR)

5 Was visual identification aided by other means? (DR)

(b) Was direct electronic identification used by the fire unit? (DR)

(c) Were both visual and direct electronic identification used by the fire unit? (DR)

(d) Was alerting used as the means of identification by the fire unit? (DR)

(e) Was cueing used as the means of identification by the fire unit? (DR)

(f) Was a command initiated fire direction order used as the means of identification by the fire unit? (DR)

(8) What was the primary reason the fire unit identified the aircraft as it did?

(a) Did the fire unit perceive that the aircraft was committing a hostile act? (DR)

(b) Did the fire unit perceive that the aircraft violated hostile criteria? (DR)

(c) Did the fire unit identify based on visual aircraft recognition? (DR)

(d) Did the fire unit perceive that the aircraft was violating an ASM measure? (DR)

DR (e)-(g) Same as 1.1.1.1.1.1.1.1.1.5h(7)(d)-(f)

(h) What other reason was used to identify the aircraft?

1.1.1.1.1.1.1.2 What was the impact of hostile rotary wing aircraft making multiple passes with respect to the weapon system position? (MOP)

1.1.1.1.1.1.1.3 What was the impact of hostile rotary wing aircraft transiting the weapon system position? (MOP)

1.1.1.1.1.2.2 To what degree did cueing information contribute to the impact of visual identification? (MOP)

1.1.1.1.1.2.3. To what degree did receiving no alerting or cueing information affect the impact of visual identification? (MOP)

1.1.1.1.1.2 What was the impact of the electronic identification means on the Stinger contribution to the number of hostile rotary wing aircraft killed? (MOP)

1.1.1.1.1.3 What was the impact of requiring both visual and electronic means of identification on the Stinger contribution to the number of hostile rotary wing aircraft killed? (MOP)

1.1.1.1.2 To what degree did SGT York contribute to the number of hostile rotary wing aircraft engaged and killed given engagement opportunities? (MOP)

1.1.1.1.3 To what degree did Chaparral contribute to the number of hostile rotary wing aircraft engaged and killed given engagement opportunities? (MOP)

1.1.1.1.4 To what degree did Vulcan/PIVADS contribute to the number of hostile rotary wing aircraft engaged and killed given engagement opportunities? (MOP)

1.1.1.1.5 To what degree did US Roland contribute to the number of hostile rotary wing aircraft engaged and killed given engagement opportunities? (MOP)

1.1.1.1.6 To what degree did Hawk contribute to the number of hostile rotary wing aircraft engaged and killed given engagement opportunities? (MOP)

1.1.1.1.7 To what degree did Patriot contribute to the number of hostile rotary wing aircraft engaged and killed given engagement opportunities? (MOP)

1.1.1.2 What was the number of hostile fixed wing aircraft engaged, killed, and the number of engagement opportunities? (MOP)

1.1.2. What was the percent of friendly aircraft killed? (MOE)

1.2 What was the impact of indirect aircraft identification procedures on the effectiveness of forward area air defense systems? (System)

DATA HANDLING

1. Date Requirements. Each data requirement in Figure A-3 will be recorded, examined to determine its impact upon the identification process, and significant results identified for further investigation. A narrative discussion will be used. Further treatment of the DRs will be addressed in the detailed test plan, the data collection plan, and the data reduction plan.

2. Measures of Performance.

a. Range Band Examination. The range of the aircraft relative to the weapon system location will be recorded to the nearest 1-km range band at the time of detection, identification, engagement, and kill. The distribution of detection, identification, engagement, and kill ranges will be displayed on a frequency histogram by 1-km range bands for both inbound and outbound aircraft to allow evaluation of the significance of aircraft direction. Additional data input information will be analyzed to determine the significance of the information to the identification process. Significant results will be reported in narrative format. See Table A-1.

TABLE A-1. SINGLE PASS

RANGE BAND	DETECTED IN/OUTBOUND	CORRECTLY IDENTIFIED IN/OUTBOUND	ENGAGED IN/OUTBOUND	KILLED IN/OUT BOUND
0-1				
1-2				
2-3				
3-4				
4-5				
5-6				
,-7				
TOTAL				

b. Flight Profile MOP. The number of aircraft making single and multiple passes with respect to the weapon system position will be recorded as carried forward from Table A-1. The number of engagement opportunities presented to the weapon system by the aircraft will also be recorded as a basis for comparing detection, identification, engagement, and kill ratios between single and multiple pass aircraft. A "multivariate analysis" will be performed to determine if there is any significant difference between the engagement and kill ratios of single and multiple pass aircraft. If no significant differences exist, the number of engagement opportunities, detections, correct identifications, engagements, and kills will be summed across single and multiple pass categories to determine the overall contributions of alerting information to visual identification. See table A-2.

TABLE A-2. DIRECT ALERT

	NUMBER OF AIRCRAFT	ENGAGEMENT OPPORTUNITIES	DETECTED	CORRECTLY IDENTIFIED	ENGAGED	KILLED
SINGLE PASS						
MULTIPLE PASS						
TOTAL						

c. Early Warning MOP. The totals for alerting, cueing and no information across single and multiple pass aircraft will be recorded as carried forward from Table A-2. A test of proportions will be performed to determine if there is any significant differences in the engagement and kill ratios, versus engagement opportunities when cueing, alerting, or no information is provided. The number of aircraft enagement opportunities, detections, correct identifications, engagements, and kills will be summed across all three categories of warning information to determine the impact of visual identification on the Stinger contribution. The accuracy of the identification will be calculated as the percent correctly identified by dividing the number correctly identified by the number of detections. See Table A-3.

TABLE A-3. VISUAL IDENTIFICATION

	ENGAGEMENT OPPORTUNITIES	DETECTED	CORRECTLY IDENTIFIED	ENGAGED	KILLED	ACCURACY OF ID
ALERTED						
CUED						
NONE						
TOTAL						

d. Means of Identification MOP. The totals for visual, electronic, and both means of identification across all levels of early warning information will be regarded as carried forward from Table A-3. A test of proportions will be performed to determine if there is any significant difference in the engagement and kill ratios of aircraft engagement opportunities between direct visual, electronic, or combined means. The number of aircraft engagement opportunities, detections, correct identifications, engagements, and kills will be summed across the visual, electronic, and combined means of identification, to determine the Stinger contribution in each area. See Table A-4.

TABLE A-4. STINGER

	ENGAGEMENT OPPORTUNITIES	DETECTED	CORRECTLY IDENTIFIED	ENGAGED	KILLED
VISUAL					
ELECTRONIC					
BOTH					
TOTAL					

e. Air Defense System MOP. The totals for each type weapon system across all means of identification will be recorded as carried forward from Table A-4. For each weapon system type, the number of hostile rotary wing aircraft engaged and killed will be divided by the number of engagement opportunities to determine each weapon system mean kill and engagement ratio. These ratios will be tested for significant differences between each other using a Newman-Kauls test. The number of engagement opportunities, detections, correct identifications, engagements, and kills will be summed across all weapon systems to determine the total number of engagement opportunities, engagements, and kills. See Table A-5.

TABLE A-5. ROTARY WING

	ENGAGEMENT OPPORTUNITIES	DETECTED	CORRECTLY IDENTIFIED	ENGAGED	KILLED
STINGER					
SGT YORK					
CHAPARRAL					
US ROLAND					
HAWK					
PATRIOT					
TOTAL					

f. Aircraft Category MOP. The totals for rotary and fixed wing aircraft across all weapon systems will be recorded as carried forward from Table A-5. Tests of proportions will be conducted to determine if there is any statistical significance in the difference between rotary hostile and fixed wing hostile aircraft killed, engaged, and engagement opportunities. If there is no statistical difference, the rotary and fixed wing number killed, engaged, and engagement opportunities will be combined, yielding the total number of hostile aircraft killed, engaged, and engagement opportunities. If there is statistical significance in the different categories, the values will not be combined but will be reported separately. See Table A-6.

TABLE A-6. HOSTILE AIRCRAFT

	ENGAGEMENT OPPORTUNITIES	ENGAGED	KILLED
ROTARY WING			
FIXED WING			
TOTAL			

3. Measures of Effectiveness.

a. Percent of Aircraft. The totals for hostile and friendly aircraft across both aircraft categories will be recorded as carried forward from Table A-6. The impact of direct identification procedures will be expressed in terms of the percent of hostile and friendly aircraft engaged and killed by dividing the respective number of aircraft engaged and killed by the total engagement opportunities of both friendly and hostile aircraft. See Table A-7. A similar table will be developed for the Indirect Identification System.

TABLE A-7. DIRECT IDENTIFICATION

	ENGAGEMENT OPPORTUNITIES	ENGAGED		KILLED	
		TOTAL	PERCENT	TOTAL	PERCENT
HOSTILE AIRCRAFT					
FRIENDLY AIRCRAFT					

b. Identification Systems. Direct and indirect identification system results will be recorded as carried forward from Table A-7. The degree to which the collective means of identification influence FAAD system effectiveness will be measured in terms of hostile and friendly aircraft engaged and killed out of the total engagement opportunities presented to a specified air defense system. The percent of friendly and hostile aircraft engaged and killed will be compared for each set of identification procedures. A "multivariate analysis" will be performed on the number of hostile and friendly aircraft engaged and killed in each set of identification procedures to determine if there is any statistically significant difference between identification systems. All analyses will be performed using an alpha risk level of 0.05. See Table A-8.

TABLE A-8. IDENTIFICATION ISSUE

	HOSTILE (%)		FRIENDLY (%)	
	ENGAGED	KILLED	ENGAGED	KILLED
DIRECT				
INDIRECT				

APPENDIX B

ISSUE 2: COMMAND, CONTROL, COMMUNICATION, AND INTELLIGENCE (C^3I)

ANALYSIS PLAN

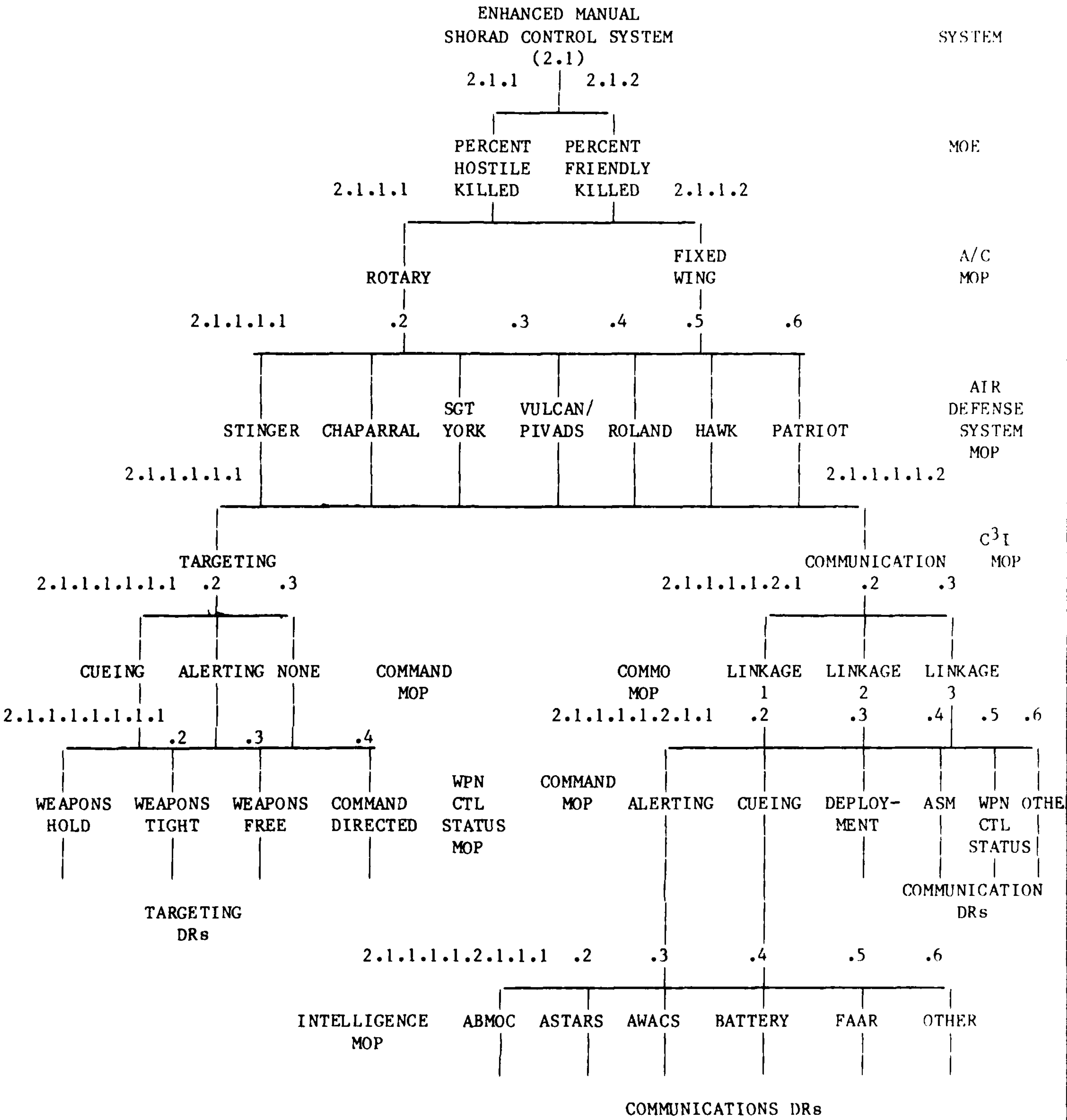


Figure B-1. Pattern of Analysis for Enhanced Manual SHORAD Control System.

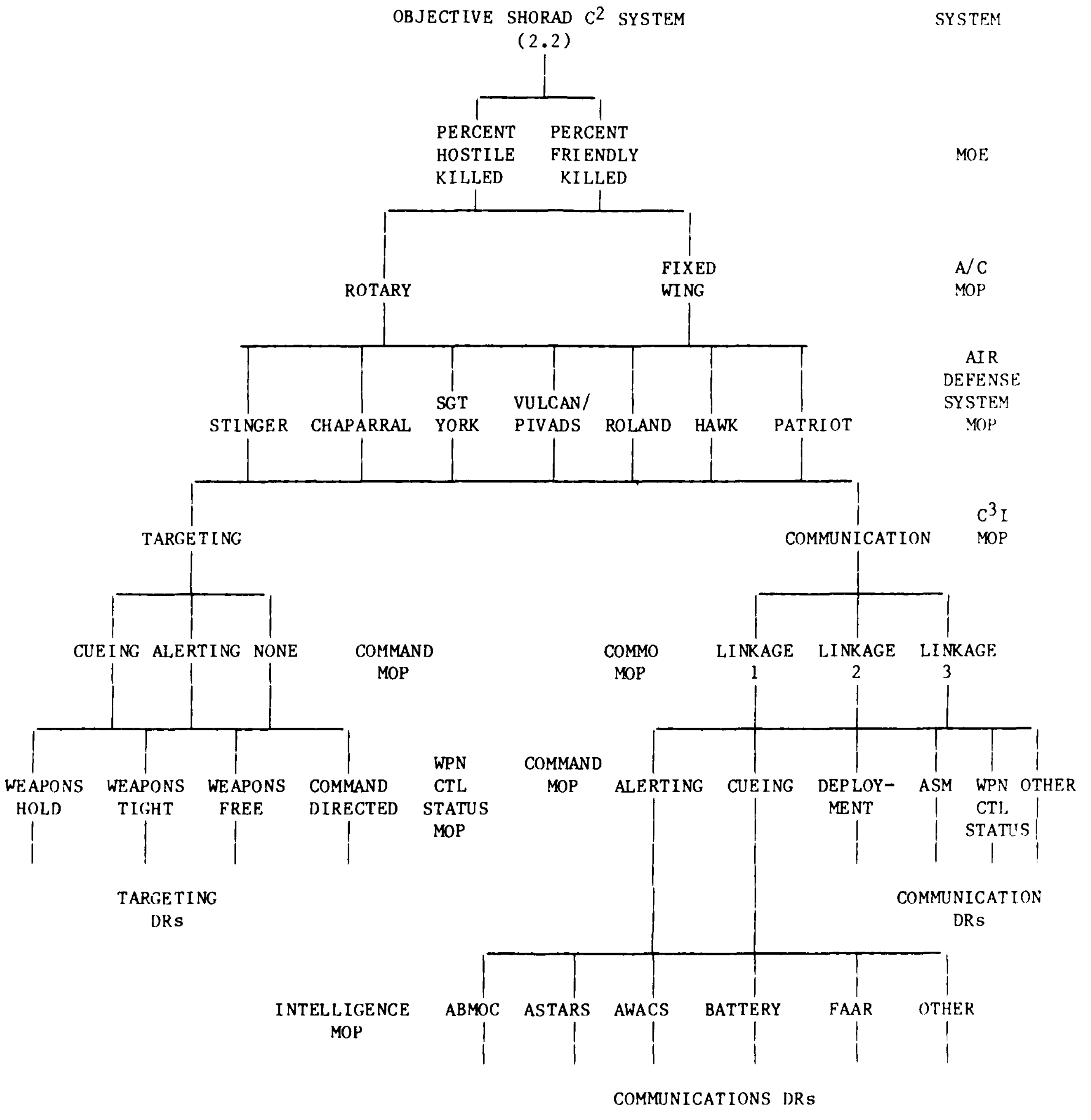


Figure B-2. Pattern of Analysis for Objective SHORAD C^2 System.

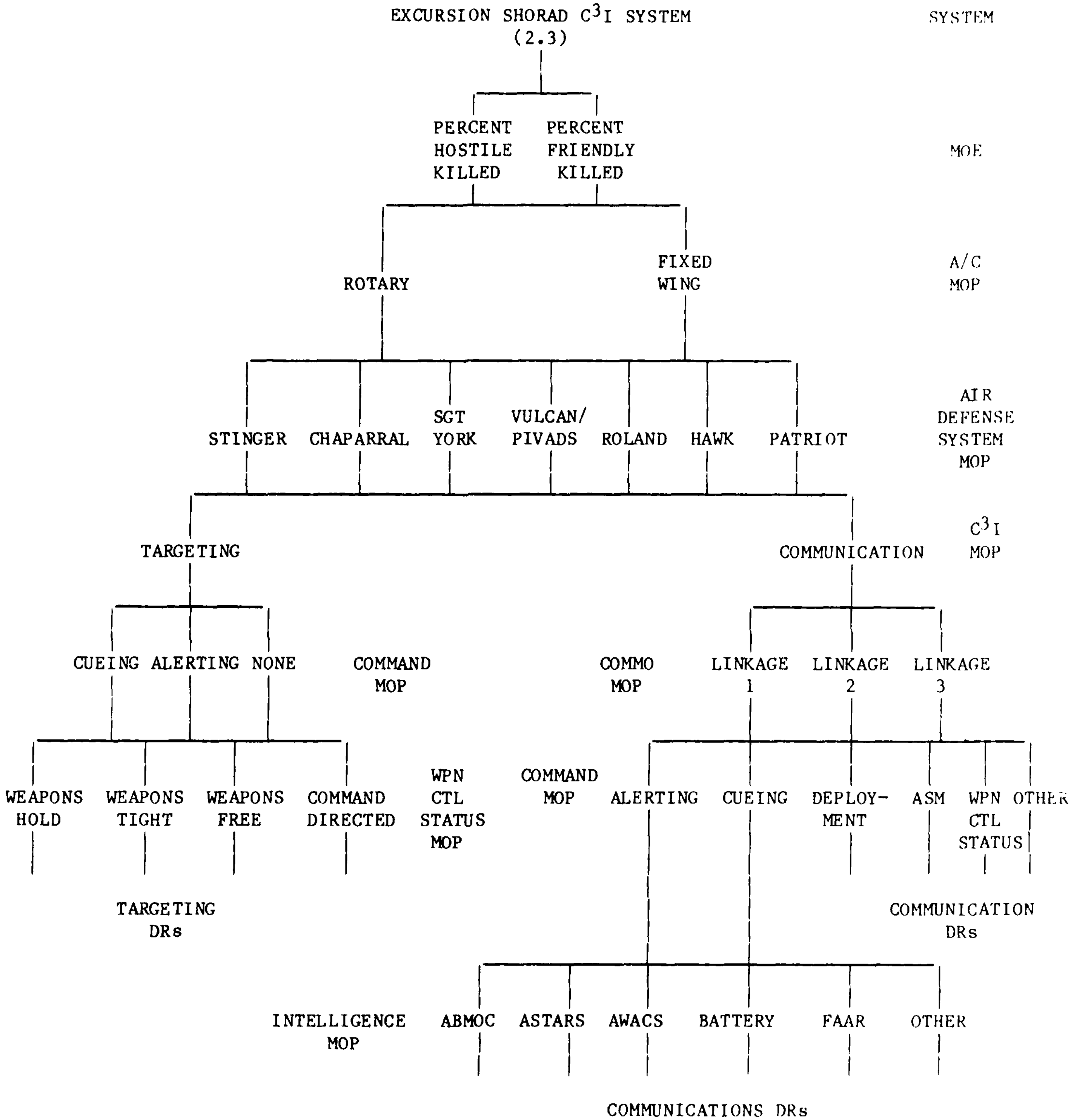


Figure B-3. Pattern of Analysis for Excursion SHORAD C^3I System.

- 2.1.1.1.1.1.1.1.1 WEAPONS HOLD/ WEAPONS TIGHT/ WEAPONS FREE/ COMMAND DIRECTED
  - 2.1.1.1.1.1.1.1.1.1 AIRCRAFT
    - a ID
    - b CATEGORY
    - c TAG
    - d TYPE
    - e PROFILE
      - (1) ATTACKING
      - (2) TRANSITING
  - .2 FIRE UNIT
    - a TYPE
    - b TAG
    - c LEFT SECTOR
    - d RIGHT SECTOR
    - e LOCATION XYZ
    - f WPN CTL STATUS
    - g MOVEMENT
      - (1) TIME BEGAN
      - (2) TIME COMPLETED
    - h TIME OUT OF AMMO
  - .3 SENSOR
    - a TYPE
    - b TAG
    - c LEFT SECTOR
    - d RIGHT SECTOR
    - e LOCATION XYZ
  - .4 MESSAGE
    - a TYPE
    - b TAG
    - c TIME RCVD
    - d ID RCVD
    - e CATEGORY RCVD
    - f LOCATION RCVD
  - .5 EVENTS
    - a ENTER DETECT
    - b DETECT '
    - c ENTER ENGAGE '
    - d ENGAGE '
    - e KILL '
    - f EXIT ENGAGE '
    - g EXIT DETECT '
      - (1) LOCATION
        - (a) HEADING
        - (b) AIRCRAFT XYZ
        - (c) FIRE UNIT XYZ
      - (2) TIME
      - (3) AIRCRAFT SPEED
    - h IDENTIFY
      - (1) LOCATION
        - (a) HEADING
        - (b) AIRCRAFT XYZ
        - (c) FIRE UNIT XYZ
      - (2) TIME
      - (3) AIRCRAFT SPEED
      - (4) PERCEIVED ID
      - (5) PERCEIVED CATEGORY
      - (6) PERCEIVED PROFILE

Figure B-4. Targeting Data Requirements for C^3I Issue.

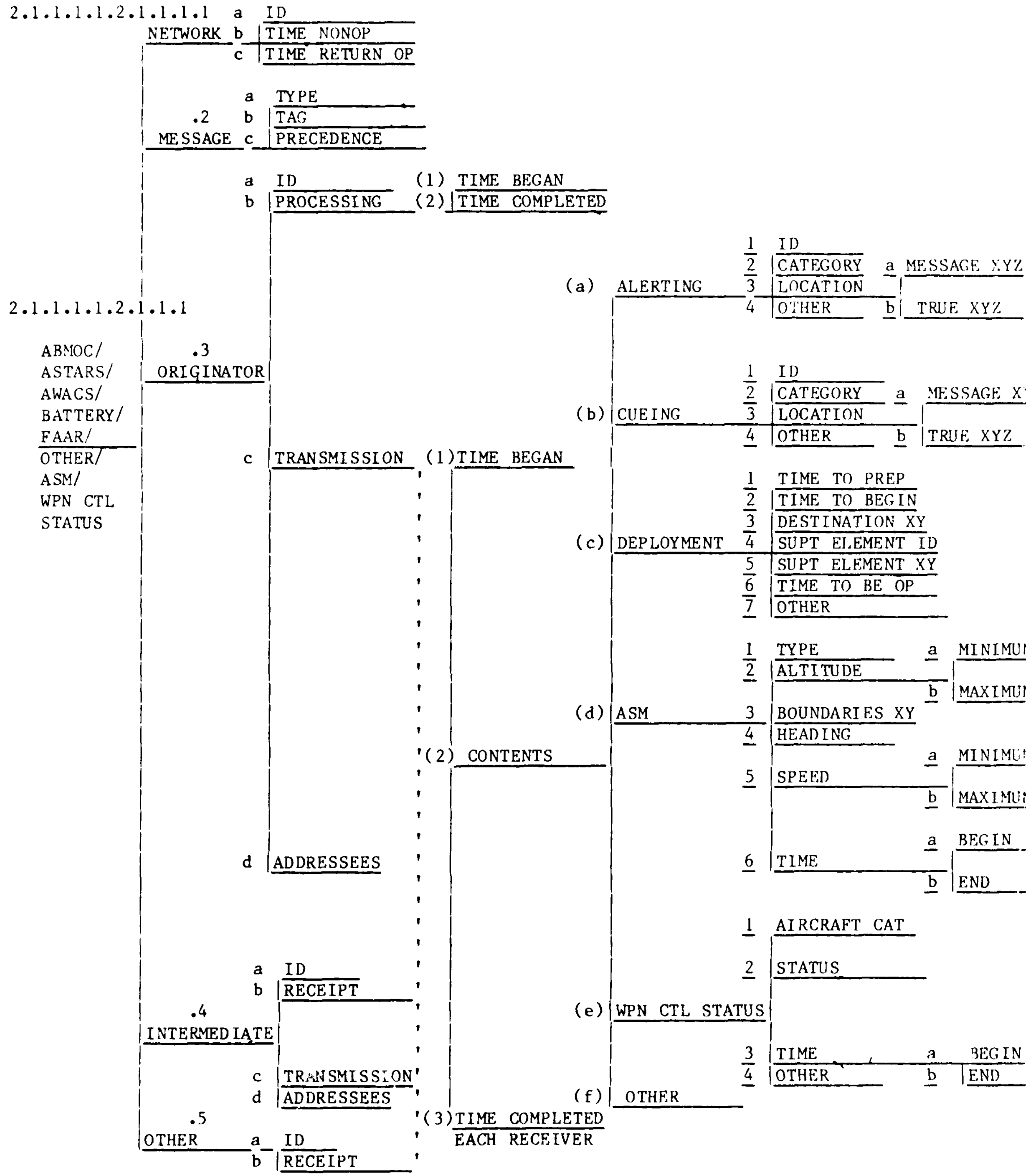


Figure B-5. Communications Data Requirements for C^3I Issue

PATTERN OF ANALYSIS

2.0 To what degree do projected C^3I capabilities support forward area air defense (FAAD) elements? (Issue)

2.1 What was the impact of the Enhanced Manual SHORAD Control System on FAAD elements? (System)

2.1.1 What was the percent of hostile aircraft killed? (MOE)

2.1.1.1 What was the number of hostile rotary wing aircraft engaged, engagement opportunities, overflights, and aircraft killed? (MOP)

2.1.1.1.1 To what degree did Stinger contribute to the number of hostile rotary wing aircraft, engaged, engagement opportunities, overflights, and aircraft killed? (MOP)

2.1.1.1.1.1 What was the impact of targeting information on the Stinger contribution to the number of hostile rotary wing aircraft killed? (MOP)

2.1.1.1.1.1.1 What was the impact of cueing information on the number of engagements and kills by Stinger? (MOP)

2.1.1.1.1.1.1.1 To what degree did operating under Weapons Hold influence the alerted weapon system? (MOP)

2.1.1.1.1.1.1.1.1 What were the aircraft parameters influencing the C^3I process?

a. What was the aircraft identification? (DR)

b. What was the aircraft category? (DR)

c. What was the aircraft tag? (DR)

d. What was the aircraft type? (DR)

e. What was the aircraft profile?

(1) Was the aircraft attacking the fire unit? (DR)

(2) Was the aircraft transiting the fire unit's zone? (DR)

2.1.1.1.1.1.1.1.2 What were the fire unit parameters influencing the C^3I process?

a. What was the fire unit type? (DR)

b. What was the fire unit tag? (DR)

c. What was the fire unit's left sector limit in degrees (magnetic)? (DR)

d. What was the fire unit's right sector limit in degrees (magnetic)? (DR)

e. What was the fire unit's location in X, Y, and Z? (DR)

f. What was the weapon control status at the fire unit? (DR)

g. What was the fire unit movement information influencing the C^3I process?

(1) What was the DTG the fire unit began a deployment? (DR)

(2) What was the DTG the fire unit completed a deployment? (DR)

h. What was the DTG the fire unit ran out of ammunition? (DR)

2.1.1.1.1.1.1.1.3 What were the sensor parameters influencing the C^3I process?

a. What was the sensor type? (DR)

b. What was the sensor tag? (DR)

c. What was the sensor's left sector limit in degrees (magnetic)? (DR)

d. What was the sensor's right sector limit in degrees (magnetic)? (DR)

e. What was the sensor's location in X, Y, and Z? (DR)

2.1.1.1.1.1.1.1.4 What were the message parameters influencing the C^3I process?

a. What was the message type? (DR)

b. What was the message tag? (DR)

c. What was the DTG message receipt was completed at the fire unit? (DR)

d. What was the aircraft identification received by the fire unit? (DR)

e. What was the aircraft category received by the fire unit? (DR)

f. What was the aircraft location received by the fire unit? (DR)

2.1.1.1.1.1.1.1.5 What were the engagement sequence parameters influencing the C^3I process?

a. What were the information elements when the aircraft entered the fire unit's detection zone?

(1) What was the location information when the aircraft entered the fire unit's detection zone?

(a) What was the aircraft heading? (DR)

(b) What was the aircraft location in X, Y, and Z? (DR)

(c) What was the fire unit location in X, Y, and Z? (DR)

(2) What was the DTG the aircraft entered the fire unit's detection zone? (DR)

(3) What was the aircraft's ground speed when the aircraft entered the fire unit's detection zone? (DR)

b. What were the information elements when the aircraft was detected by the fire unit?

c. What were the information elements when the aircraft entered the fire unit's engagement zone?

d. What were the information elements when the aircraft was engaged by the fire unit?

e. What were the information elements when the aircraft was killed by the fire unit?

f. What were the information elements when the aircraft exited the fire unit's engagement zone?

g. What were the information elements when the aircraft exited the fire unit's detection zone?

2.1.1.1.1.1.5b thru g -Same as a(1) thru (3)

h. What were the information elements when the aircraft was identified by the fire unit?

(1) thru (3) -Same as 2.1.1.1.1.1.1.1.5a(1) thru (3)

(4) What was the fire unit's perception of the aircraft identification? (DR)

(5) What was the fire unit's perception of the aircraft category? (DR)

(6) What was the fire unit's perception of the aircraft profile? (DR)

2.1.1.1.1.1.1.2 To what degree did operating under Weapons Tight influence the alerted weapons system? (MOP)

2.1.1.1.1.1.1.3 To what degree did operating under Weapons Free influence the alerted weapon system? (MOP)

2.1.1.1.1.1.1.4 To what degree did command initiated fire direction orders influence the alerted weapon system? (MOP)

2.1.1.1.1.1.2 What was the impact of alerting information on the number of engagements and kills by Stinger? (MOP)

2.1.1.1.1.1.3 What was the impact of operating without cueing or alerting information on the number of engagements and kills by Stinger? (MOP)

2.1.1.1.1.2 What was the impact of the communication system on the Stinger contribution to the number of hostile rotary wing aircraft killed?

2.1.1.1.1.2.1 What was the impact of C^3I linkage #1 on the Stinger communication system effectiveness? (MOP)

2.1.1.1.1.2.1.1 What was the effectiveness of alerting information impacting on the communication network? (MOP)

2.1.1.1.1.2.1.1.1 To what degree did sensors and/or communication nodes (i.e., ABMOC, ASTARS, AWACS, Battery, FAAR, or other sources) contribute to the effectiveness of alerting information (passed directly and/or indirectly to the weapon system)? (MOP)

2.1.1.1.1.2.1.1.1.1 What were the parameters of the communication network influencing the C^3I process?

a. What was the identification of the communication network? (DR)

b. What was the DTG the communication network became nonoperational? (DR)

c. What was the DTG the communication network returned to operation? (DR)

2.1.1.1.1.2.1.1.1.2 What were the parameters of the message influencing the C^3I process?

a. What was the message type? (DR)

b. What was the message tag? (DR)

c. What was the message precedence? (DR)

2.1.1.1.1.2.1.1.1.3 What were the parameters of the message originator influencing the C^3I process?

a. What was the identification of the message originator? (DR)

b. What was the processing information of the message originator?

(1) What was the DTG message preparation began? (DR)

(2) What was the DTG message preparation was completed? (DR)

c. What was the transmission information of the message originator?

(1) What was the DTG message transmission began? (DR)

(2) What were the contents of the message transmitted?

(a) What were the contents of the alerting message?

1. What was the aircraft identification in the message? (DR)

2. What was the aircraft category in the message? (DR)

3. What was the aircraft location?

a. What were the X, Y, and Z location in the message? (DR)

b. What was the true aircraft location in X, Y, and Z at the time the message was transmitted and received? (DR)

4. What was the other information included in the message? (DR)

(b) What were the contents of the cueing message?

DR 1 thru 4 -Same as (a)1 thru 4, above (DR)

(c) What were the contents of the deployment message?

1. What was the DTG specified for the addressee to prepare for deployment? (DR)

2. What was the DTG specified for the addressee to begin deployment? (DR)

3. What was the addressee's destination location in X and Y? (DR)

4. What was the identification of the element to be supported at the destination location? (DR)

5. What was the location in X and Y of the elements to be supported from the destination location? (DR)

6. What was the DTG specified for the addressee to be operational in the destination location? (DR)

7. What was the other information included in the message? (DR)

(d) What were the contents of the airspace management message?

1. What was the type of airspace management measure? (DR)

2. What was the altitude of the airspace management measure? (DR)

a. What was the minimum altitude of the airspace measure? (DR)

b. What was the maximum altitude of the airspace management measure? (DR)

3. What were the boundaries of the airspace management measure in X and Y? (DR)

4. What was the allowed heading within the airspace management measure? (DR)

5. What was the aircraft speed allowed in the airspace measure?

a. What was the minimum aircraft speed allowed in the airspace management measure? (DR)

b. What was the maximum aircraft speed allowed in the airspace management measure? (DR)

6. What was the effective time of the airspace measure?

a. What was the beginning effective time of the airspace management measure? (DR)

b. What was the ending effective time of the airspace management measure? (DR)

(e) What were the contents of the weapon control status message?

1. What was the aircraft category to which the weapon control status would apply? (DR)

2. What was the new weapon control status? (DR)

3. What was the effective time of the weapon control status?

a. What was the beginning effective time of the weapon control status? (DR)

b. What was the ending effective time of the weapon control status? (DR)

4. What was the other information included in the weapon control status message? (DR)

(f) What were the contents of the other messages? (DR)

(3) What was the DTG message transmission was completed at each receiver? (DR)

d. Who were the message addressees? (DR)

2.1.1.1.1.2.1.1.1.4 What were the parameters of the intermediate network elements influencing the C^3I process?

a. What was the identification of the intermediate element? (DR)

b. What was the message receipt information of the intermediate element?

DR (1) thru (3) -Same as 2.1.1.1.1.2.1.1.1.3c(1) th u (3), above.

c. What was the transmission information of the intermediate element?

DR (1) thru (3) -Same as 2.1.1.1.1.2.1.1.1.3c(1) thru (3), above (DR)

d. Who were the message addressees? (DR)

2.1.1.1.1.2.1.1.1.5 What were the parameters of other information influencing the C^3I process?

a. What was the identification of the message addressee? (DR)

b. What was the message receipt information of the addressee? (DR)

DR (1) thru (3) -Same as 2.1.1.1.1.2.1.1.1.3c(1) thru (3), above (DR)

2.1.1.1.1.2.1.2 What was the effectiveness of cueing information impacting on the communication network? (MOP)

2.1.1.1.1.2.1.3 What was the effectiveness of deployment information impacting on the communication system? (MOP)

2.1.1.1.1.2.1.4 What was the effectiveness of airspace management information impacting on the communication system? (MOP)

2.1.1.1.1.2.1.5 What was the effectiveness of weapons control status information impacting on the communication system? (MOP)

2.1.1.1.1.2.1.6 What was the effectiveness of other information impacting on the communication linkage? (MOP)

2.1.1.1.1.2.2 What was the impact of C^3I linkage #2 on the Stinger communication system effectiveness? (MOP)

2.1.1.1.1.2.3 What was the impact of C^3I linkage #3 on the Stinger communication system effectiveness? (MOP)

2.1.1.1.2 To what degree did Chaparral contribute to the number of hostile rotary wing aircraft engaged, engagement opportunities, overflights, and aircraft killed? (MOP)

2.1.1.1.3 To what degree did SGT York contribute to the number of hostile rotary wing aircraft engaged, engagement opportunities, overflights, and aircraft killed? (MOP)

2.1.1.1.4 To what degree did Vulcan/PIVADS contribute to the number of hostile rotary wing aircraft engaged, engagement opportunities, overflights, and aircraft killed? (MOP)

2.1.1.1.5 To what degree did US Roland contribute to the number of hostile rotary wing aircraft engaged, engagement opportunities, overflights, and aircraft killed? (MOP)

2.1.1.1.6 To what degree did Hawk contribute to the number of hostile rotary wing aircraft engaged, engagement opportunities, overflights, and aircraft killed? (MOP)

2.1.1.1.7 To what degree did Patriot contribute to the number of hostile rotary wing aircraft engaged, engagement opportunities, overflights, and aircraft killed? (MOP)

2.1.1.2 What was the number of hostile fixed wing aircraft engaged, engagement opportunities, overflights and aircraft killed? (MOP)

2.1.2 What was the percent of friendly aircraft killed? (MOE)

2.2 What was the impact of the Objective SHORAD C^2 system on FAAD elements? (System)

2.3 What was the impact of a JFAAD proposed C^3I System on FAAD elements? (System)

DATA HANDLING

1. Data Requirements. Each data requirement contained in Figures B-4 and B-5 will be recorded, examined to determine the impact upon the C^3I system, and significant results identified for further investigation. A narrative discussion will be used. Further treatment of the DRs will be addressed in the detailed test plans, the data collection plan, and the data reduction plan.

2. Measures of Performance.

a. Intelligence MOP. A comparison between nodes in the communication system will be made by examining the timeliness, accuracy, and usefulness of alerting information received both directly and indirectly by the fire unit. The timeliness of the information is calculated as the number of messages received too late to influence the fire unit's detection of the aircraft. The accuracy of the information will be computed as the number of alerting messages where one or more elements of the message received by the fire unit was incorrectly perceived. The usefulness of the information will be calculated as the number of messages where all elements of the alerting message were received in time to influence the fire unit's detection of the aircraft by properly orienting the fire unit. By tests of proportion between nodes, the analysis will center on each node's capability to provide quality alerting information, both directly to the weapon system and indirectly to the weapon system, consistent with the architecture of the communication linkage available. Similar analysis of cueing information will provide the basis for determining the value of sensors and intermediate notes for the receipt and transmission of both alerting and cueing information. The totals across each column of the data table will be computed by summing all rows within each column. The total columns within the "Direct Information to the Weapons System" will be carried forward to higher level data presentations. See Table B-1.

TABLE B-1. COMMUNICATION NODAL PERFORMANCE

		SENSOR INFO PROCESSING		INDIRECT INFORMATION TO THE WEAPONS SYSTEM				DIRECT INFORMATION TO THE WEAPONS SYSTEM			
		A/C INFO AVAIL	TRANS- MITTED	INFO AVAIL	RCVD USEFUL	RCVD ON TIME BUT INACCURATE	RCVD LATE	INFO AVAIL	RCVD USEFUL	RCVD ON TIME BUT INACCURATE	RCVD LATE
ABMOC	CUEING										
	ALERTING										
ASTARS	CUEING										
	ALERTING										
AWACS	CUEING										
	ALERTING										
BATTERY	CUEING										
	ALERTING										
FAAR	CUEING										
	ALERTING										
OTHER SOURCES	" " " " " " " "										
TOTAL	CUEING										
	ALERTING										

b. Communication, Command and Control MOP. The totals for direct alerting and cueing information will be recorded as carried forward from Table B-1. Similar data on other message types will be compiled from the data requirements. A comparison between the categories of information transmitted over the linkage will be made by examining the timeliness, accuracy, and usefulness of command, control, intelligence information in the linkage. The timeliness of the information will be displayed by providing the number of messages received too late to cause the fire unit to take the appropriate action. The inaccuracy of the information will be displayed by providing the number of messages where one or more elements of the message received by the fire unit was incorrectly perceived by the fire unit. The usefulness of the information will be displayed by providing the number of messages where all elements of the message were received at the fire unit in time to allow proper orientation of the fire unit. Each linkage will be analyzed in terms of the network's ability to provide quality information by each category of command, control, and intelligence information. The totals across each column of the data table will be computed by summing all rows within each column. See Table B-2.

TABLE B-2. COMMUNICATION LINKAGE 1 PERFORMANCE

	INFORMATION AVAILABLE	RECEIVED USEFUL	RECEIVED LATE	RECEIVED ON TIME BUT INACCURATE
CUEING				
ALERTING				
DEPLOYMENT				
AIRSPACE MANAGEMENT				
WPN CONTROL STATUS				
OTHER				
TOTAL				

c. Communication MOP. The cueing and alerting results will be recorded as carried forward from Table B-2. A comparison between the linkages will be made by examining the timeliness, accuracy, and usefulness of message traffic in terms of cueing and alerting information. The timeliness of the linkage is displayed by providing the number of messages received too late to cause the fire unit to take the appropriate action. The inaccuracy of the linkage will be displayed by providing the number of messages where one or more elements of the message received by the fire unit was incorrectly perceived by the fire unit. The usefulness of a linkage will be displayed by providing the number of messages where all elements of the message were received the fire unit in time to allow proper orientation of the fire unit. Each linkage will be analyzed in terms of its ability to provide quality cueing and alerting information. The totals across each column of the data table will be computed by summing all rows within each column. See Table B-3.

TABLE B-3. COMMUNICATION SYSTEM IMPACT ON TARGETING INFORMATION

		INFORMATION AVAILABLE	RECEIVED USEFUL	RECEIVED LATE	RECEIVED ON TIME BUT INACCURATE
LINKAGE 1	CUEING				
	ALERTING				
LINKAGE 2	CUEING				
	ALERTING				
LINKAGE 3	CUEING				
	ALERTING				
TOTAL	CUEING				
	ALERTING				

d. Weapon Control Status MOP. Entries across each row are compiled from examining the controlled input variable values for all events conducted during each test. Tests of proportion will be performed on the ratios of engaged to engagement opportunities to determine if there is a significant difference between weapons control statuses. The total number of aircraft killed, engaged, engagement opportunities and aircraft overflights will be calculated by summing the number of aircraft killed, engaged, engagement opportunities, and aircraft overflights by each weapon control status and command initiated fire direction orders. See Table B-4.

TABLE B-4. WEAPONS SYSTEM ALERTED

	AIRCRAFT OVERFLIGHTS	OPPORTUNITIES	ENGAGED	KILLED	ACCURACY OF PERCEPTION	
					ID	LOCATION
WEAPONS HOLD						
WEAPONS TIGHT						
WEAPONS FREE						
COMMAND DIRECTED						
TOTAL						

e. Targeting Command and Control MOP. Entries will be recorded as carried forward from Table B-4. Tests of proportion will be conducted to determine if there is any significant difference between cued, alerted, or no targeting information in terms of the relationship of engagements to engagement opportunities. The total number of aircraft killed, engaged, engagement opportunities, and aircraft overflights will be calculated by summing the number of aircraft killed, engaged, engagement opportunities, and aircraft overflights by each type weapon system. See Table B-5.

TABLE B-5. WEAPONS SYSTEM TARGETING INFORMATION

	AIRCRAFT OVERFLIGHTS	ENGAGEMENT OPPORTUNITIES	ENGAGED	KILLED
CUEING				
ALERTED				
NONE				
TOTAL				

f. C^3I MOP. Entries will be recorded by correlating results from Tables B-3 and B-5. The impact of targeting information in terms of aircraft overflights, engagement opportunities, engagements, and kills will be grouped into cueing and alerting information available in the system. The targeting information portion of the results showing the impact of the communication system will be displayed in terms of cued, miscued, and not cued results; alerting, misalerted, and not alerted results; and results when no information is available in the system. The results will allow an analysis of the system's ability to generate and disseminate targeting information in terms of engagement outcomes. A test of proportion will be performed on cued and alerted results versus not cued, not alerted and no information available to determine if the system can significantly contribute to engagement results by providing quality targeting information. A test of proportion will also be performed on miscued and misalerted results if the system can significantly degrade engagement results by providing erroneous targeting information. (Miscue, or misalert, is defined as inaccurate information. Not cued, or not alerted, is defined as untimely information.) See Table B-6.

TABLE B-6. COMMUNICATION IMPACT ON STINGER ENGAGEMENT SEQUENCE OUTCOME

		AIRCRAFT OVERFLIGHTS	ENGAGEMENT OPPORTUNITIES	ENGAGED	KILLED
CUEING INFORMATION AVAILABLE	CUED				
	MISCUED				
	NOT CUED				
ALERTING INFORMATION AVAILABLE	ALERTED				
	MISALERTED				
	NOT ALERTED				
NO INFORMATION AVAILABLE					
TOTAL					

g. Air Defense System MOP. The results from each weapon system will be recorded as carried forward from Table B-6. The type of weapon system will be rank ordered by engagement opportunities from greatest number to least. A chi-square goodness of fit test will be performed to determine if the number of engagements by weapon system type conform to their engagement opportunities. The total number of hostile rotary wing aircraft killed, engaged, engagement opportunities, and aircraft overflights will be calculated by summing the number of aircraft killed, engaged, engagement opportunities, and aircraft overflights by each type weapons system. See Table B-7.

TABLE B-7. ROTARY WING

	AIRCRAFT OVERFLIGHTS	ENGAGEMENT OPPORTUNITIES	ENGAGED	KILLED
STINGER				
CHAPARRAL				
SGT YORK				
US ROLAND				
HAWK				
PATRIOT				
TOTAL				

h. Aircraft Category MOP. The results for each aircraft category will be recorded as carried forward from Table B-7. Tests of proportions will be conducted to determine if there is any statistical significance in the difference between rotary and fixed wing aircraft killed, engaged, and engagement opportunities. If there is no statistical difference, the rotary and fixed wing number killed, engaged, and engagement opportunities will be combined, yielding the total number of hostile aircraft killed, engaged, and engagement opportunities. If there is statistical significance in the different categories, the values will not be combined but will be reported separately. See Table B-8.

TABLE B-8. HOSTILE AIRCRAFT

	AIRCRAFT OVERFLIGHTS	ENGAGEMENT OPPORTUNITIES	ENGAGED	KILLED
ROTARY WING				
FIXED WING				
TOTAL				

3. Measures of Effectiveness.

a. Percent of Aircraft. The results for hostile and friendly aircraft will be recorded as carried forward from Table B-8. The impact of the Enhanced Manual SHORAD Control System will be expressed in terms of the percent of hostile and friendly aircraft killed and engaged by dividing the respective number of aircraft engaged or killed by the total killed and engaged by the total engagement opportunities for both hostile and friendly aircraft. See Table B-9. Similar tables will be developed for the Objective SHORAD C^2 System and the Excursion SHORAD C^3I System.

TABLE B-9. ENHANCED MANUAL SHORAD CONTROL SYSTEM.

	AIRCRAFT OVERFLIGHTS	ENGAGEMENT OPPORTUNITIES	ENGAGED		KILLED	
			TOTAL	PERCENT	TOTAL	PERCENT
HOSTILE AIRCRAFT						
FRIENDLY AIRCRAFT						

b. Command and Control System. The MOE results for each system will be recorded as carried forward from Table B-9. The issue will be measured through the percent of hostile and friendly aircraft killed and engaged out of the total engagement opportunities presented to a specified air defense system. The percent of hostile and friendly aircraft killed and engaged will be compared for each C^3I architecture. An analysis of variance (ANOVA) will be performed on the number of hostile and friendly aircraft killed and engaged in each architecture to determine if there is any statistically significant difference between architectures. All analyses will be performed using an alpha risk level of 0.05. See Table B-10.

TABLE B-10. C^3I ISSUE.

	HOSTILE (%)		FRIENDLY (%)	
	ENGAGED	KILLED	ENGAGED	KILLED
ENHANCED MANUAL SHORAD CONTROL SYSTEM				
OBJECTIVE SHORAD C^2 SYSTEM				
EXCURSION SHORAD C^3I SYSTEM				

APPENDIX C

ISSUE 3: AIRSPACE MANAGEMENT (ASM)

ANALYSIS PLAN

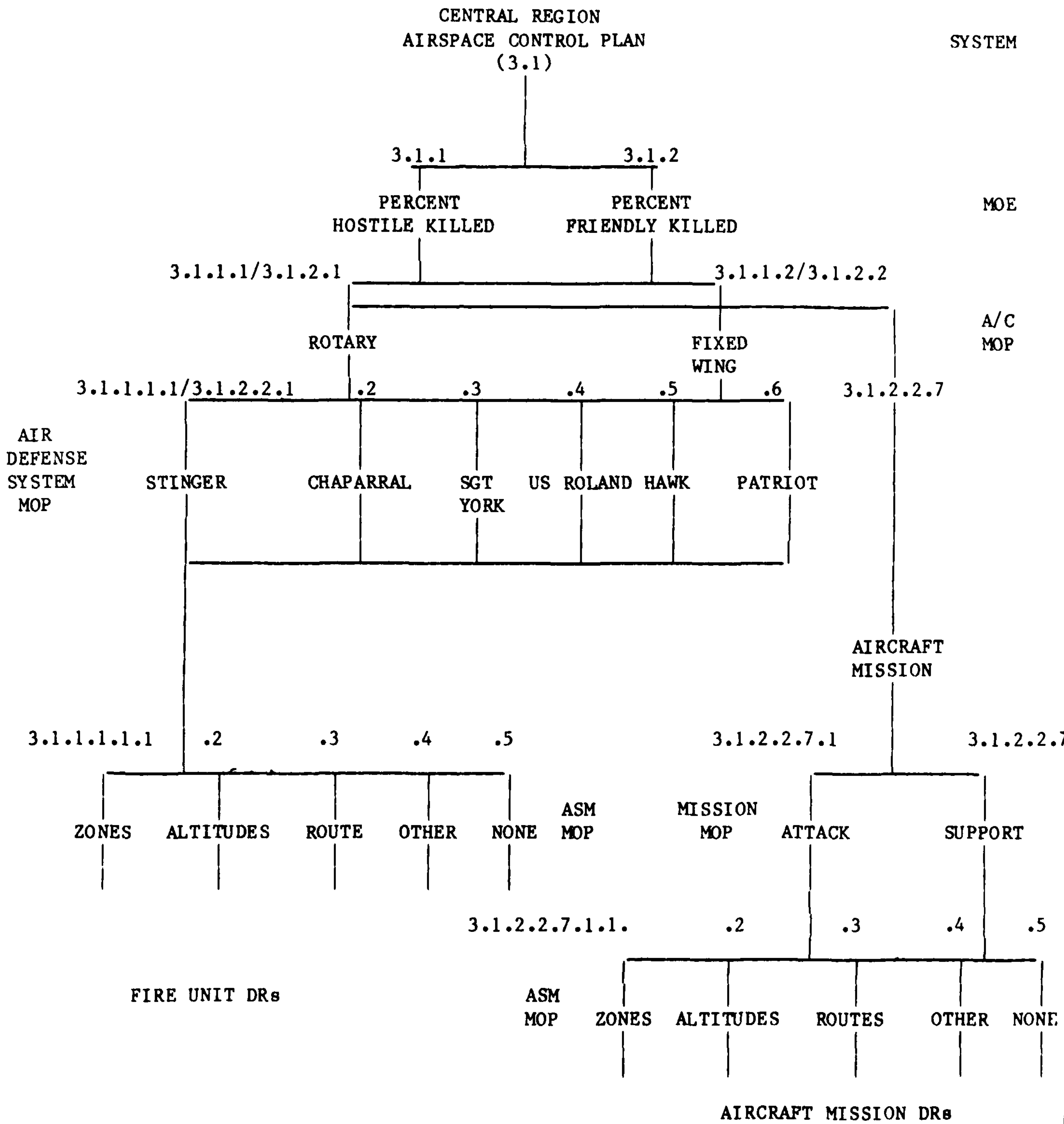


Figure C-1. Pattern of Analysis for Central Region Airspace Control Plan System.

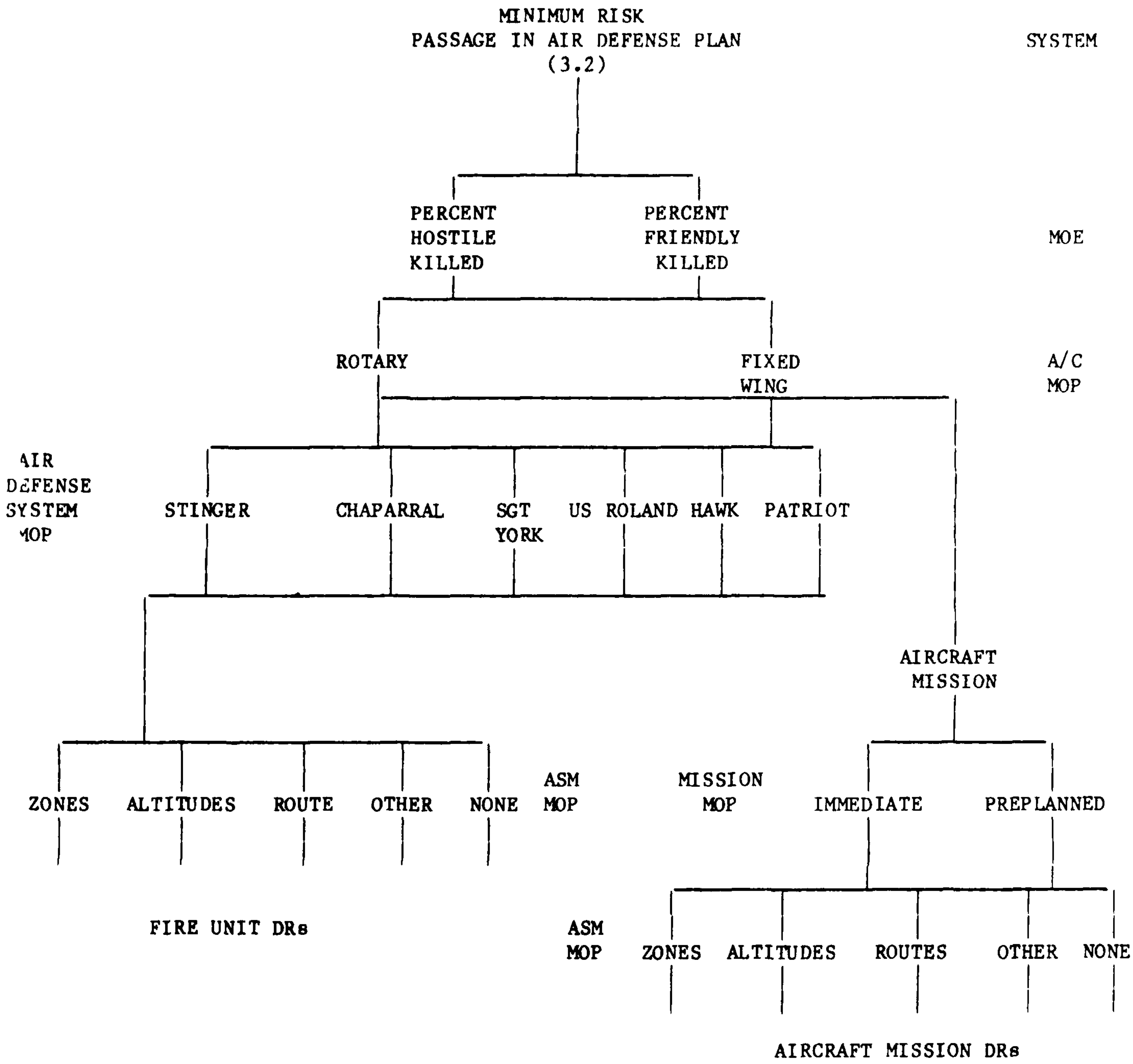


Figure C-2. Pattern of Analysis for Minimum Risk Passage In Air Defense Plan System.

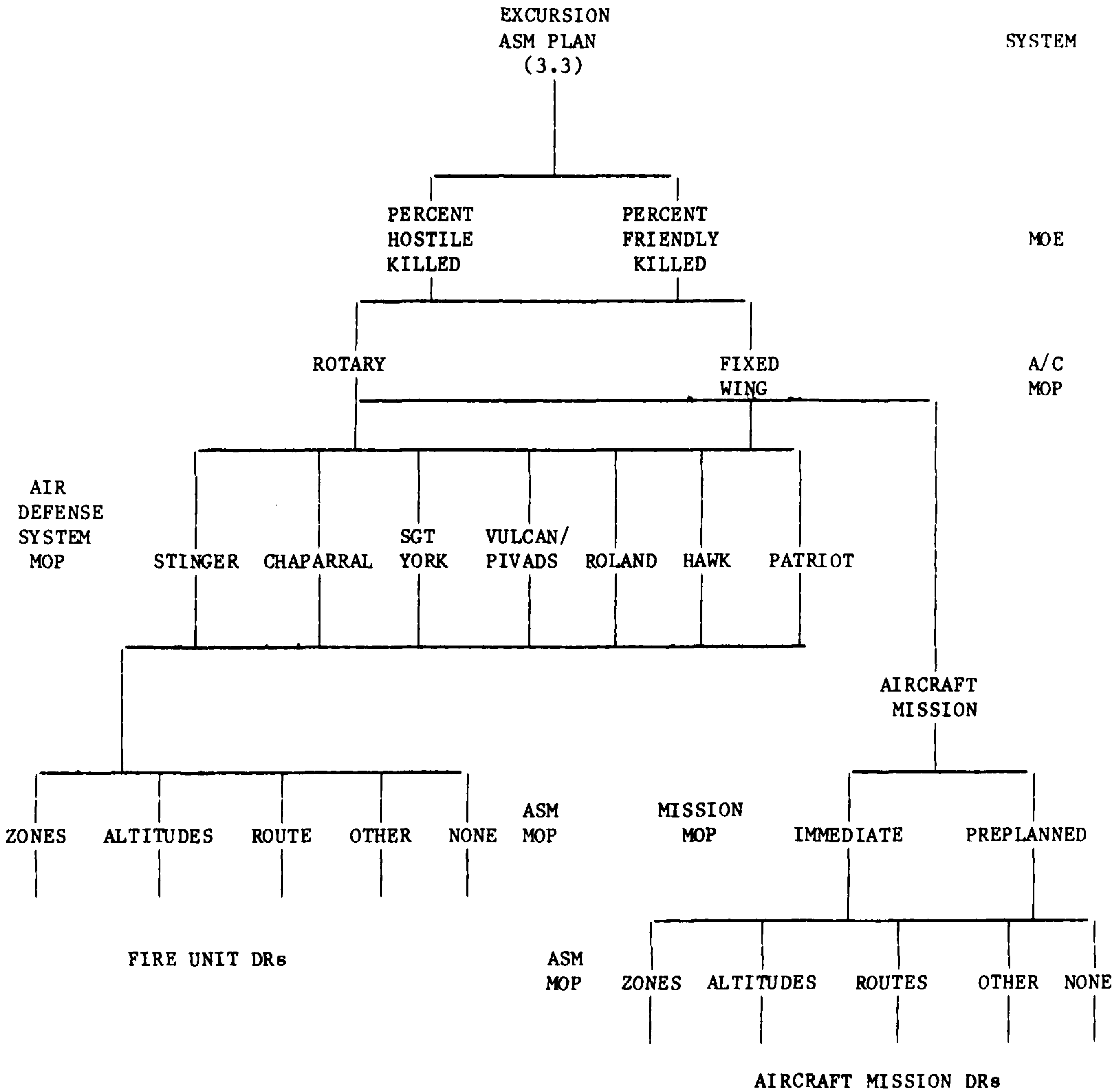


Figure C-3. Pattern of Analysis for Excursion ASM Plan System.

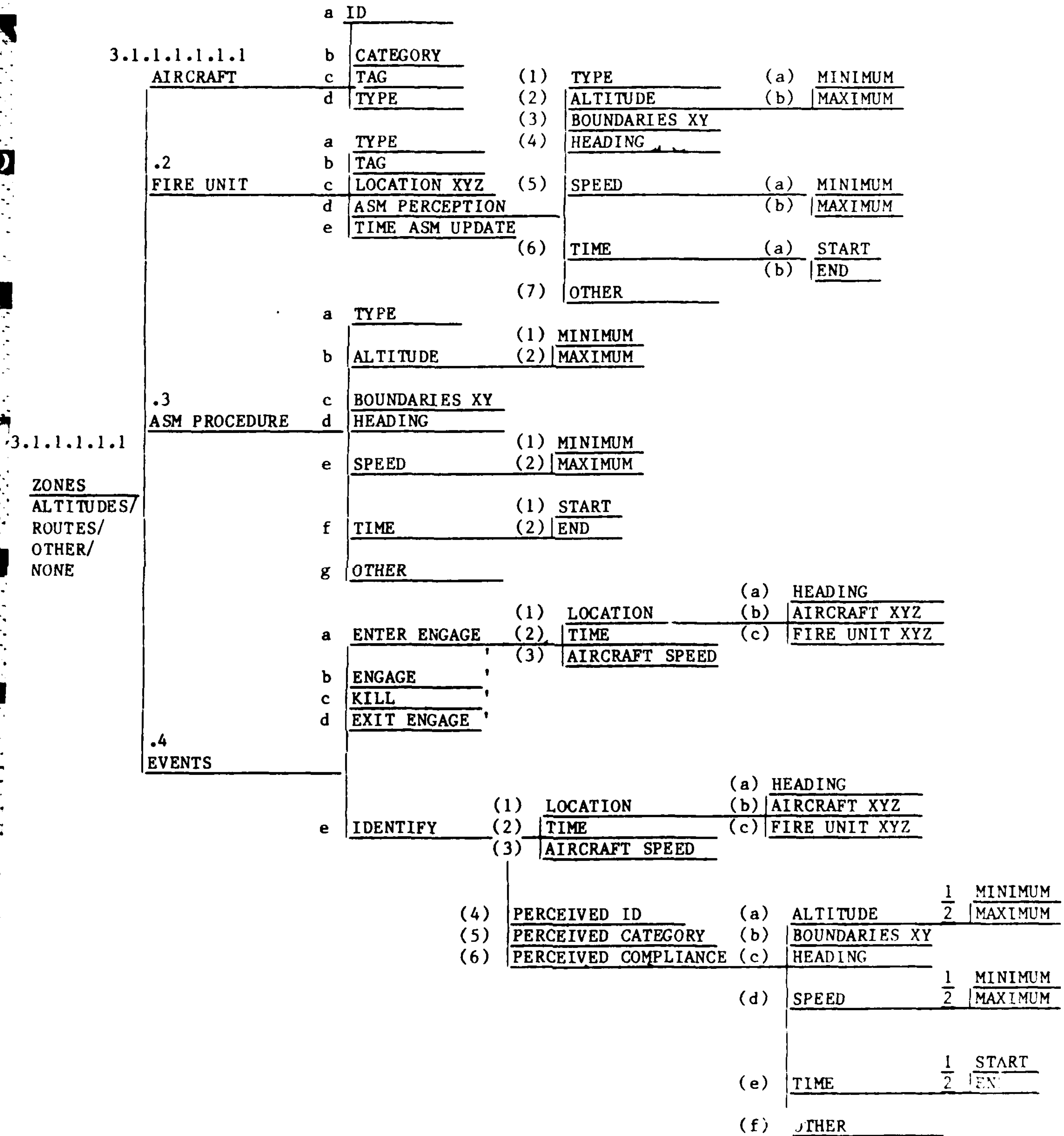


Figure C-4. Fire Unit Mission Data Requirements for Airspace Management Issue.

3.1.2.2.7.1.1
ZONES/ ALTITUDES/ ROUTES/ OTHER/ NONE

- 3.1.2.2.7.1.1.1 AIRCRAFT
  - a ID
  - b CATEGORY
  - c TAG
  - d TYPE
  - e MISSION
    - (1) ATTACK (ROTARY)
    - (2) SUPPORT (ROTARY)
    - (3) PREPLANNED (FW)
    - (4) IMMEDIATE (FW)
    - (5) NON-COMBAT (ROTARY)
    - (6) CLOSE AIR (BOTH)
    - (7) AIR INTERDICTION (FW)
    - (8) OTHER (BOTH)
- .2 FIRE UNIT
  - a TYPE
  - b TAG
  - c LEFT SECTOR
  - d RIGHT SECTOR
  - e LOCATION XYZ
- .3 ASM PROCEDURE
  - a TYPE
  - b ALTITUDE
    - (1) MINIMUM
    - (2) MAXIMUM
  - c BOUNDARIES XY
  - d HEADING
  - e SPEED
    - (1) MINIMUM
    - (2) MAXIMUM
  - f TIME
    - (1) START
    - (2) END
  - OTHER
- .4 EVENTS
  - a RECEIVE REQUEST
    - (1) TIME
    - (2) PRIMARY TARGET XY
    - (3) PRIMARY TARGET TAG
    - (4) PREFERRED TIME-ON-TARGET
    - (5) NOT-LATER-THAN TIME-ON-TARGET
  - b INITIATE SUPPORT
    - (1) TIME
    - (2) AIRCRAFT XYZ
  - c FRATRICIDE
    - (1) TIME
    - (2) FIRE UNIT TAG
    - (3) FIRE UNIT TYPE
  - d PRIMARY TARGET
    - (1) ARRIVAL TIME
    - (2) TARGET XY
    - (3) TARGET TAG
    - (4) SUPPORT PROVIDED
    - (5) OPPORTUNITY LOST DUE TO ASM DELAY
    - (6) NOT SUPPORTED DUE TO ASM
  - e ALTERNATE TARGET
    - (1) ARRIVAL TIME
    - (2) TARGET XY
    - (3) TARGET TAG
    - (4) SUPPORT PROVIDED

Figure C-5. Aircraft Mission Data Requirements for Airspace Management Issue.

3. How does forward area airspace management (ASM) and control affect mission accomplishment of forward area air defense systems and friendly aircraft? (Issue)

3.1 What was the impact of the Central Region Airspace Control Plan on mission accomplishment of FAAD and friendly aircraft? (System)

3.1.1 What was the percent of hostile aircraft killed? (MOE)

3.1.1.1 What was the number of hostile rotary wing aircraft killed? (MOP)

3.1.1.1.1 To what degree did Stinger contribute to the number of hostile rotary wing aircraft killed? (MOP)

3.1.1.1.1.1 What was the impact of ASM zones on the Stinger contribution to the number of hostile rotary wing aircraft engaged, engagement opportunities, and aircraft killed? (MOP)

3.1.1.1.1.1.1 What was the aircraft information influencing the ASM process? (MOP)

a. What was the aircraft identification? (DR)

b. What was the aircraft category? (DR)

c. What was the aircraft tag? (DR)

d. What was the aircraft type? (DR)

3.1.1.1.1.1.2 What was the fire unit information influencing the ASM process?

a. What was the fire unit type? (DR)

b. What was the fire unit tag? (DR)

c. What was the fire unit's location in X, Y, and Z? (DR)

d. What was the fire unit's perception of the ASM procedure in effect?

(1) What was the fire unit's perception of the type of ASM procedure? (DR)

(2) What was the fire unit's perception of the altitude o the airspace measure? (DR)

(a) What was the fire unit's perception of the minimum altitude of the ASM measurer? (DR)

(b) What was the fire unit's perception of the maximum altitude of the ASM measure? (DR)

(3) What was the fire unit's perception of the boundaries of the ASM measure in X and Y? (DR)

(4) What was the fire unit's perception of the allowed heading within the ASM measure? (DR)

(5) What was the fire unit's perception of the speed required in the ASM measure?

(a) What was the fire unit's perception of the minimum speed required in the ASM measure? (DR)

(b) What was the fire unit's perception of the maximum speed allowed in the ASM measure? (DR)

(6) What was the fire unit's perception of the effective time of ASM measure?

(a) What was the fire unit's perception of the starting effective time of the ASM measure? (DR)

(b) What was the fire unit's perception of the ending effective time of the ASM measure? (DR)

(7) What was the fire unit's perception of other ASM measures in effect?

e. What was the DTG the fire unit's perception of the ASM measure was updated? (DR)

3.1.1.1.1.1.3 What was the actual ASM information influencing the ASM process?

a thru g -Same as d(1) thru d(7), above.

3.1.1.1.1.1.4 What was the engagement sequence information influencing the ASM process?

a. What were the information elements when the aircraft entered the fire unit's engagement zone?

(1) What was the location information when the aircraft entered the fire unit's engagement zone?

(a) What was the aircraft heading? (DR)

(b) What was the aircraft location in X, Y and Z? (DR)

(c) What was the fire unit location in X, Y, and Z? (DR)

(2) What was the DTG the aircraft entered the fire unit's engagement zone? (DR)

(3) What was the aircraft's ground speed when the aircraft entered the fire unit's engagement zone? (DR)

b. What were the information elements when the aircraft was engaged by the fire unit?

c. What were the information elements if the aircraft was killed by the fire unit? (DR)

d. What were the information elements when the aircraft exited the fire unit's engagement zone? (DR)

3.1.1.1.1.1.4b thru d -Same as a(1) thru (3)

e. What were the information elements when the aircraft was identified by the fire unit? (DR)

(1) thru (3) -Same as 3.1.1.1.1.1.4a(1) thru (3)

(4) What was the fire unit's perception of the aircraft identification? (DR)

(5) What was the fire unit's perception of the aircraft category? (DR)

(6) What was the fire unit's perception of the aircraft compliance with the perceived ASM procedure?

(a) Did the fire unit perceive that the aircraft compliance was within the altitude of the ASM measure?

1 Did the fire unit perceive that the aircraft was complying with the minimum altitude of the ASM measure? (DR)

2 Did the fire unit perceive that the aircraft was complying with the maximum altitude of the ASM measure? (DR)

(b) Did the fire unit perceive that the aircraft was complying with the boundaries of the ASM measure? (DR)

(c) Did the fire unit perceive that the aircraft was complying with the allowed heading of the ASM measure? (DR)

(d) Did the fire unit perceive that the aircraft compliance was within the speed of the ASM measure?

1 Did the fire unit perceive that the aircraft was complying with the minimum speed of the ASM measure? (DR)

2 Did the fire unit perceive that the aircraft was complying with the maximum speed of the ASM measure? (DR)

(e) Did the fire unit perceive that the aircraft compliance was within the effective time of the ASM measure?

1 Did the fire unit perceive that the aircraft was complying with the starting effective time of the ASM measure? (DR)

2 Did the fire unit perceive that the aircraft was complying with the ending effective time of the ASM measure? (DR)

(f) Did the fire unit perceive aircraft compliance with other ASM procedures in effect? (DR)

3.1.1.1.1.2 What was the impact of ASM altitudes on the Stinger contribution to the number of hostile rotary wing aircraft engaged, engagement opportunities, and aircraft killed? (MOP)

3.1.1.1.1.3 What was the impact of ASM routes on the Stinger contribution to the number of hostile rotary wing aircraft engaged, engagement opportunities, and aircraft killed? (MOP)

3.1.1.1.1.4 What was the impact of other ASM measures on the Stinger contribution to the number of hostile rotary wing aircraft engaged, engagement opportunities, and aircraft killed? (MOP)

3.1.1.1.1.5 What was the impact of operating without ASM measures on the Stinger contribution to the number of hostile rotary wing aircraft engaged, engagement opportunities, and aircraft killed? (MOP)

3.1.1.1.2 To what degree did Chaparral contribute to the number of hostile rotary wing aircraft engaged, engagement opportunities, and aircraft killed? (MOP)

3.1.1.1.3 To what degree did SGT York contribute to the number of hostile rotary wing aircraft engaged, engagement opportunities, and aircraft killed ? (MOP)

3.1.1.1.4 To what degree did US Roland contribute to the number of hostile rotary wing aircraft engaged, engagement opportunities, and aircraft killed? (MOP)

3.1.1.1.5 To what degree did Hawk contribute to the number of hostile rotary wing aircraft engaged, engagement opportunities, and aircraft killed ? (MOP)

3.1.1.1.6 To what degree did Patriot contribute to the number of hostile rotary wing aircraft engaged, engagement opportunities, and aircraft killed ? (MOP)

3.1.1.2 What was the number of hostile fixed wing aircraft engaged, engagement opportunities, and aircraft killed? (MOP)

3.1.2 What was the percent of friendly aircraft killed? (MOE)

3.1.2.2 What was the number of friendly fixed wing aircraft engaged, engagement opportunities, and aircraft killed? (MOP)

3.1.2.2.7 To what degree ASM affect friendly fixed wing aircraft mission accomplishment? (MOP)

3.1.2.2.7.1 To what degree were fixed wing attack aircraft affected by ASM measures? (MOP)

3.1.2.2.7.1.1 What was the impact of ASM zones on friendly rotary wing attack aircraft? (MOP)

3.1.2.2.7.1.1.1 What was the aircraft information influencing the aircraft mission accomplishment?

a. What was the aircraft identification? (DR)

b. What was the aircraft category? (DR)

c. What was the aircraft tag? (DR)

d. What was the aircraft type? (DR)

e. What was the aircraft mission?

(1) Was the aircraft mission attack (rotary wing)? (DR)

(2) Was the aircraft mission support (rotary wing)? (DR)

(3) Was the aircraft mission preplanned (fixed wing)? (DR)

(4) Was the aircraft mission immediate (fixed wing)? (DR)

(5) Was the aircraft mission type non-combat (rotary wing)? (DR)

(6) Was the aircraft mission type close air support (rotary wing or fixed wing)? (DR)

(7) Was the aircraft mission type air interdiction (fixed wing)? (DR)

(8) Was the aircraft mission in another category (both)? (DR)

3.1.2.2.7.1.1.2 What were the fire unit parameters, influenced by ASM information, affecting the aircraft mission accomplishment?

a. What was the fire unit type? (DR)

b. What was the fire unit tag? (DR)

c. What was the left sector limit in degrees (magnetic)? (DR)

d. What was the right sector limit in degrees (magnetic)? (DR)

e. What was the fire unit's location in X, Y, and Z? (DR)

3.1.2.2.7.1.1.3 What was the ASM information influencing the aircraft mission accomplishment?

a. What was the type of ASM measure? (DR)

b. What was the altitude of the ASM measure?

(1) What was the minimum altitude of the ASM measure? (DR)

(2) What was the maximum altitude of the ASM measure? (DR)

c. What were the boundaries of the ASM measure in X and Y?(DR)

d. What was the allowed heading within the ASM measure? (DR)

e. What was the speed required in the ASM measure?

(1) What was the minimum speed required in the ASM measure? (DR)

(2) What was the maximum speed allowed in the ASM measure? (DR)

f. What was the effective time of the ASM measure?

(1) What was the starting effective time of the ASM measure? (DR)

(2) What was the ending effective time of the ASM measure? (DR)

3.1.2.2.7.1.1.4 What was the aircraft event sequence information influencing the aircraft mission accomplishment?

a. What were the information elements when the aircraft received the support request?

(1) What was the DTG when the aircraft received the support requests? (DR)

(2) What was the primary target location in X and Y? (DR)

(3) What was the primary target tag? (DR)

(4) What was the preferred time on target? (DR)

(5) What was the "not-later-than" time on target? (DR)

b. What were the information elements when the aircraft initiated the support request?

(1) What was the DTG when the aircraft initiated the support request? (DR)

(2) What was the aircraft location in X, Y, and Z at the time the support request was initiated? (DR)

c. What were the information elements if the aircraft was killed by a ground air defense fire unit?

(1) What was the DTG when the aircraft was killed by a ground air defense fire unit? (DR)

(2) What was the tag of the fire unit that killed the aircraft? (DR)

(3) What was the type fire unit that killed the aircraft? (DR)

d. What were the information elements when the aircraft provided support at the primary target location?

(1) What was the DTG the aircraft arrived at the primary target location? (DR)

(2) What was the target location in X and Y? (DR)

(3) What was the target tag associated with the location at the time the aircraft arrived? (DR)

(4) Was support provided at the primary target location? (DR)

(5) Did the ASM measure cause the loss of a target opportunity at the primary target location due to a delay in arrival? (DR)

(6) Was the primary target not supported due to ASM restrictions that prevented the aircraft from reaching the primary target location? (DR)

e. What were the information elements when the aircraft provided support at an alternate target location?

(1) What was the DTG when the aircraft arrived at the alternate target location? (DR)

(2) What was the target location in X and Y? (DR)

(3) What was the target tag associated with the location at the time the aircraft arrived? (DR)

(4) Was support provided at the alternate target location? (DR)

3.1.2.2.7.1.2 What was the impact of ASM altitudes on fixed wing attack aircraft? (MOP)

3.1.2.2.7.1.3 What was the impact of ASM routes on fixed wing attack aircraft? (MOP)

3.1.2.2.7.1.4 What was the impact of other ASM measures on fixed wing attack aircraft? (MOP)

3.1.2.2.7.1.5 What was the impact of operating without any ASM measures on fixed wing attack aircraft? (MOP)

3.1.2.2.7.2. To what degree were fixed wing support aircraft affected by ASM measures? (MOP)

3.2 What was the impact of the Minimum Risk Passage in Air Defense Plan on mission accomplishment of FAAD and friendly aircraft? (System)

3.3 What was the impact of a JFAAD proposed Airspace Management Plan on mission accomplishment of FAAD and friendly aircraft? (System)

DATA HANDLING

1. Data Requirement. Each data requirement contained in Figures C-4 and C-5 will be recorded, examined to determine its impact upon the ASM system, and significant results identified for further investigation. A narrative discussion will be used. Further treatment of the DRs will be addressed in the detailed test plans, the data collection plan, and the data reduction plan.

2. Measures of Performance.

a. Aircraft Mission Examination. The impact of zones on rotary wing attack aircraft mission accomplishment will be discussed in terms of the information provided in Table C-1. The "Total Requests" column will indicate the number of times aircraft received requests for support in which the support, if provided, would be influenced by the ASM zone between the aircraft's initial position and the target location. The "Requests" Supported" column will indicate the number of requests that aircraft attempted to support, which were influenced by ASM zones. This entry will be carried forward to Table C-2. The "Delays Due to ASM" column will indicate the number of times the aircraft arrived at the preferred target location after the requested time-on-target. Since it is assumed all friendly aircraft will comply with ASM measures in effect, the delay will be a result of the compliance with ASM zones. Delays will be measured from the requested time-on-target instead of the not later than time-on target. The "Length of Delay" will indicate the average delay time for support of the preferred target which will be calculated by dividing the total delay time by the number of delays defined above. The "Delays Resulting in Lost Target" will indicate the number of times the aircraft reached the preferred target location but the support opportunity was lost at the preferred target because the ASM zones delayed the aircraft to such an extent that the target was no longer available. This column will be carried forward to Table C-2 as the "Timeliness" column. The "Alternate Targets Struck" column will indicate the number of times support was provided at the alternate target because the preferred target opportunity was lost or the preferred target could not be reached. The "Preferred Targets Not Struck Due to ASM at Target Location" column will indicate the number of times the preferred target could not be supported because the ASM zone in the target vicinity prevented the aircraft from reaching the target location. This column will be carried forward to Table C-2 as the "Targeting" column. The "Killed Enroute" column will indicate the number of times the target could not be supported because the aircraft was killed by friendly air defenses while enroute to the target. This column will be carried forward to Table C-2 as the "Fratricide" column. The percentage line will be calculated by dividing the total in each column by the number of the "Total Requests" column. See Table C-1.

TABLE C-1. ZONES

	SUPPORT		TIMELINESS			TARGETING		FRATRICIDE
	TOTAL REQUESTS	REQUESTS SUPPORTED	DELAYS DUE TO ASM	LENGTH OF DELAY	DELAYS RESULTING LOST TGT	ALTERNATE TGT STRUCK	TGT LOST DUE ASM IN AREA	KILLED ENROUTE
TOTAL NUMBER								
PERCENTAGES								

b. Aircraft Mission - Airspace Management MOP. The entries for each ASM measure will be recorded as carried forward from Table C-1. The degree of rotary wing attack aircraft mission accomplishments will be discussed in terms of the information provided in Table C-2 for each type of ASM measure, and operations when no ASM measures are in effect. The "Requests Supported" column will indicate the number of requests that aircraft attempted to support. The "Timeliness" column will indicate the number of times the support opportunity was lost at the preferred target because ASM measures delayed the aircraft from reaching the target to such an extent that the target was no longer available. The "Targeting" column will indicate the number of times the preferred support could not be provided because the ASM measure in the target vicinity prevented the aircraft from reaching the target location. The "Fratricide" column will indicate the number of times the support could not be provided because the aircraft was killed by friendly air defenses while enroute to the target. The "Mission Accomplishment" column will be calculated by subtracting the sum of the Timeliness, Targeting, and Fratricide columns from the Requests Supported column to indicate the number of missions accomplished as influenced by each type of ASM measure. A test of proportions will be performed between the number of requests supported and the number of missions accomplished for each type of ASM measure, comparing each to the results when no ASM measures were in effect to determine if there is a statistically significant difference in the results. If no significant difference exists, the totals across all ASM measures for each column of the table will be summed to provide the rotary wing attack aircraft mission accomplishment. See Table C-2.

TABLE C-2. ROTARY WING ATTACK AIRCRAFT

	REQUESTS SUPPORTED	TIMELINESS	TARGETING	FRATRICIDE	MISSION ACCOMPLISHMENT
ZONES					
ALTITUDES					
ROUTES					
OTHER					
NONE					
TOTAL					

c. Aircraft Mission MOP. The results for each fixed wing mission type will be recorded as carried forward from Table C-2. The degree of fixed wing mission accomplishment will be discussed in terms of information provided in Table C-3 for both attack and support fixed wing aircraft. The "Requests Supported" column will indicate the total number of requests that aircraft attempted to support. The "Timeliness" column will indicate the total number of times the support opportunity was lost at the perferred target because ASM measures delayed the aircraft from reaching the target to such an extent that the target was no longer available. The "Targeting" column will indicate the total number of times the preferred support could not be provided because the ASM me sure in the target vicinity prevented the aircraft from reaching the target location. The "Fratricide" column will indicate the total number of times the support could not be provided because the aircraft was killed by friendly air defenses while enroute to the target. The "Mission Accomplishment" column will be calculated by subtracting the sum of the Timeliness, Targeting, and Fratricide columns from the Requests Supported column to indicate the number of missions accomplished by attack and support fixed wing aircraft. A test of proportions will be performed between the total number of requests supported and the total number of missions accomplished by attack and support fixed wing aircraft to determine if there is a statistically significant difference in the results. If no significant difference exists, the totals by attack and support aircraft for each column of the table will be combined to provide the fixed wing aircraft mission accomplishment. See Table C-3.

TABLE C-3. FIXED WING AIRCRAFT

	REQUESTS SUPPORTED	TIMELINESS	TARGETING	FRATRICIDE	MISSION ACCOMPLISHMENT
ATTACK					
SUPPORT					
TOTAL					

d. Fire Unit Perception Examination. Table C-4 categorizes the number of opportunities the fire unit had to engage aircraft in terms of: (1) the fire unit's perception of the ASM measure in effect, and (2) the actual ASM measure in effect. The number of opportunities the fire unit has to engage aircraft is determined by the fire unit's perception of aircraft compliance/noncompliance with the ASM measure believed to be in effect. Therefore, the two main areas of investigation are: (1) the capability of the fire unit to determine the correct ASM measure in effect, and (2) the capability of the fire unit to determine compliance with an ASM measure. Separate entries will identify the capability to determine when no ASM measure is in effect. Each block in Table C-4 has been labeled A through J to facilitate the following discussion. The capability of the fire unit to determine the correct ASM measure in effect will be analyzed by the following proportion: $\frac{B + H + J}{B + D + F + H + I + J}$. The capability of the fire unit to determine compliance with an ASM measure will be examined separately for three categories: (1) cases for which the fire unit perceived the aircraft complying with an ASM measure, (2) cases for which the fire unit perceived the aircraft not complying with an ASM measure, and (3) cases for which no ASM measure was in effect. The first two categories will be investigated by the following proportions: $\frac{A}{A + C}$ (compliance), $\frac{E}{E + G}$ (uncompliance). The third category will be investigated by the proportion: $\frac{J}{I + J}$ (no ASM). Tests of proportions will be conducted among all three categories to determine if any one category is statistically different from the other. If no statistical difference exists, the overall capability of the fire unit to determine compliance with an ASM measure will be computed from: $\frac{A + G + J}{A + C + E + G + I + J}$. See Table C-4.

TABLE C-4. IMPACT OF ASM ZONES

	AIRCRAFT COMPLYING		AIRCRAFT NOT COMPLYING	
	WITH THE FIRE UNIT'S PERCEPTION OF THE ASM MEASURE	WITH THE ACTUAL ASM MEASURE	WITH THE FIRE UNIT'S PERCEPTION OF THE ASM MEASURE	WITH THE ACTUAL ASM MEASURE
FIRE UNIT'S PERCEPTION OF AIRCRAFT COMPLIANCE WITH THE ASM MEASURE	A	B	C	D
FIRE UNIT'S PERCEPTION OF AIRCRAFT NONCOMPLIANCE WITH THE ASM MEASURE	E	F	G	H
NUMBER OF TIMES THE FIRE UNIT INCORRECTLY PERCEIVED OF NO ASM MEASURE IN EFFECT				I
NUMBER OF TIMES THE FIRE UNIT CORRECTLY PERCEIVED OF NO ASM MEASURE IN EFFECT				J

e. Fire Unit - Airspace Management MOP. The accuracy of the fire unit's perception with respect to each ASM measure will be recorded as carried forward from the analysis of Table C-4. Engagement data will be compiled from test data collection. The ASM measures will be rank ordered by engagement opportunities from greatest to least. A chi-square goodness of fit test will be performed to determine if the number of engagements by ASM measures conforms to their engagement opportunities. The degree of Stinger contribution to the number of hostile rotary wing aircraft engaged and killed will be computed by summing the contribution of the impact of zones, altitudes, routes, other ASM measures, and operating without ASM measures in effect. See Table C-5.

TABLE C-5. STINGER

	ENGAGEMENT OPPORTUNITIES	ENGAGED	KILLED	ACCURACY OF PERCEPTION	
				MEASURE	COMPLIANCE
ZONES					
ALTITUDES					
ROUTES					
OTHER					
NONE					
TOTAL					

f. Weapon System Type MOP. The results for each weapon system will be recorded as carried forward from Table C-5. The type of weapons system will be rank ordered by engagement opportunities from the greatest to the least number. A chi-square goodness of fit test will be performed to determine if the number of engagements by weapons system conforms to their engagement opportunities. The total number of hostile rotary wing aircraft engaged and killed will be calculated by summing the number of aircraft engaged and killed by each type of weapons system. See Table C-6.

TABLE C-6. ROTARY WING

	ENGAGEMENT OPPORTUNITIES	ENGAGED	KILLED
STINGER			
CHAPARRAL			
SGT YORK			
US ROLAND			
HAWK			
PATRIOT			
TOTAL			

g. Aircraft Category MOP. The results for each aircraft category will be recorded as carried forward from Table C-6. Tests of proportions will be conducted to determine if there is any statistical significance in the difference between rotary and fixed wing aircraft killed and engaged. If there is no statistical difference, the number of rotary fixed wing aircraft engaged and killed will be combined, yielding the total number of hostile aircraft engaged and killed. If there is statistical significance in the different categories, the values will not be combined but will be reported separately. See Table C-7.

TABLE C-7. HOSTILE/FRIENDLY AIRCRAFT

	ENGAGEMENT OPPORTUNITIES	ENGAGED	KILLED
ROTARY WING			
FIXED WING			
TOTAL			

3. Measures of Effectiveness.

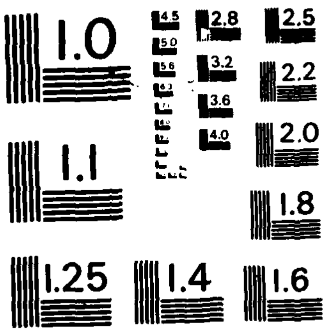
a. Percent of Aircraft. The results for hostile and friendly aircraft will be recorded as carried forward from Table C-7. The impact of the Central Region Airspace Control Plan will be expressed in terms of the percent of hostile and friendly aircraft engaged and killed by dividing the total engaged and killed by the total engagement opportunities for both hostile and friendly aircraft. See Table C-8. Similar tables will be developed for the Minimum Risk and the Excursion ASM Systems.

TABLE C-8. CENTRAL REGION AIRSPACE CONTROL PLAN

	ENGAGEMENT OPPORTUNITIES	ENGAGED		KILLED	
		TOTAL	PERCENT	TOTAL	PERCENT
HOSTILE AIRCRAFT					
FRIENDLY AIRCRAFT					

AD-A142 459 JOINT FORWARD AREA AIR DEFENSE TEST PROGRAM DEFINITION 2/2
(U) JOINT FORWARD AREA AIR DEFENSE TEST FORCE FORT
BLISS TX 30 MAR 84

UNCLASSIFIED F/G 15/3 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

b. Airspace Management Systems. The MOE results for each system will be recorded as carried forward from Table C-8. The issue will be measured in terms of the percent of hostile and friendly aircraft engaged and killed out of the total engagement opportunities presented to a specified air defense system (i.e., Stinger, SGT York, Chaparral). The percent of hostile and friendly aircraft engaged and killed will be compared for each ASM system. An analysis of variance (ANOVA) will be performed on the number of hostile and friendly aircraft engaged and killed in each system to determine if there is any statistically significant difference between systems. All analyses will be performed using an alpha risk level of 0.05. See Table C-9.

TABLE C-9. AIRSPACE MANAGEMENT ISSUE

	HOSTILE (%)		FRIENDLY (%)	
	ENGAGED	KILLED	ENGAGED	KILLED
CENTRAL REGION AIRSPACE CONTROL PLAN				
MINIMUM RISK PASSAGE PLAN				
EXCURSION ASM PLAN				

APPENDIX D

METHODOLOGY EXAMPLE

METHODOLOGY EXAMPLE

Figure D-1 presents the pattern of analysis for the direct identification system. A single analytical path has been highlighted as the path chosen for this example. Figure D-2 shows the data requirements, the fulfillment of which are necessary to support the analysis path.

Tables from the identification issue analysis plan have been generated, using fictitious data, to give the reader a clearer understanding of the relationships between DRs, MOPs, MOEs, and systems. They also show the methodology of "folding-up" data towards the end goal of resolving the test issue.

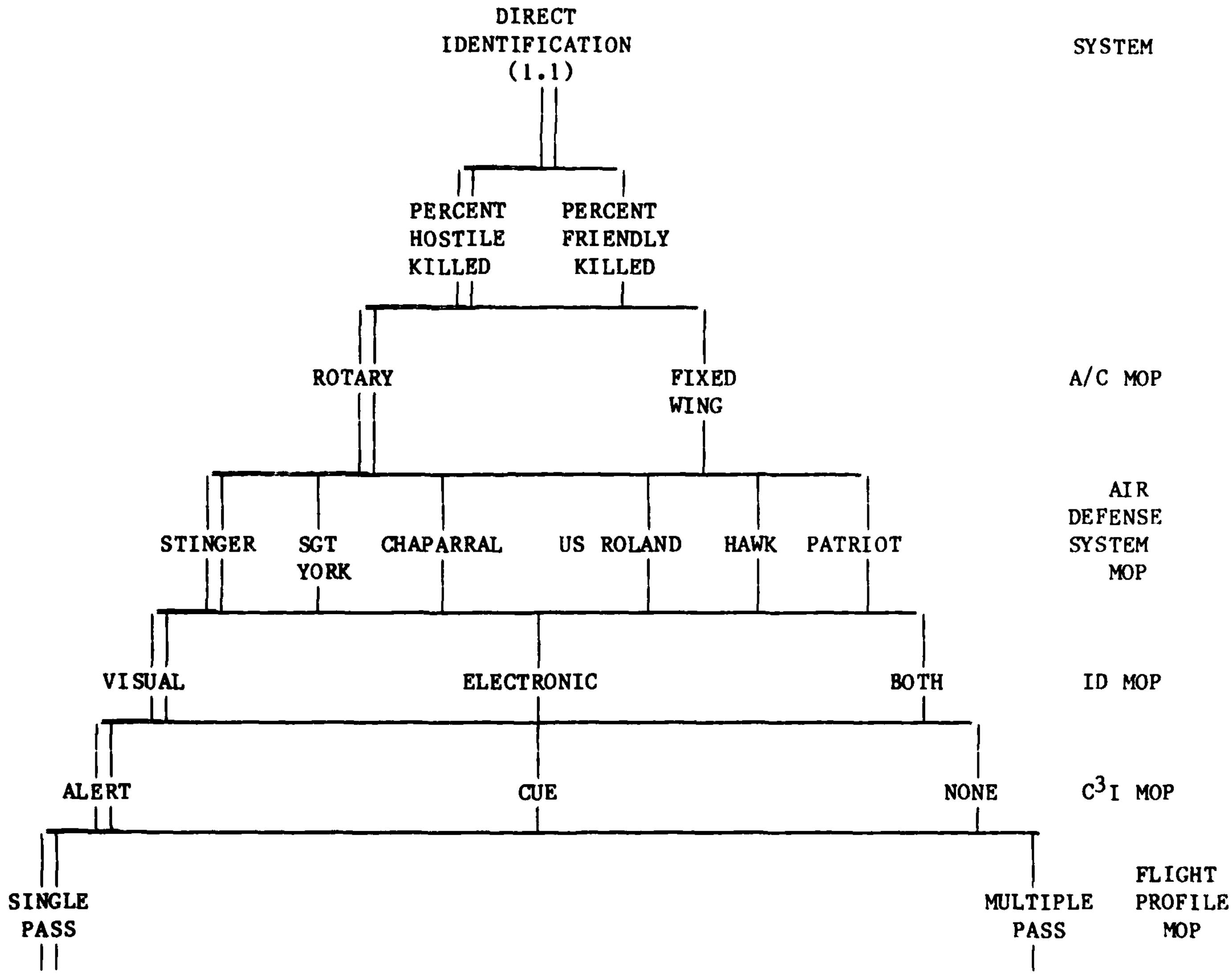


Figure D-1. Pattern of Analysis for Direct Identification System.

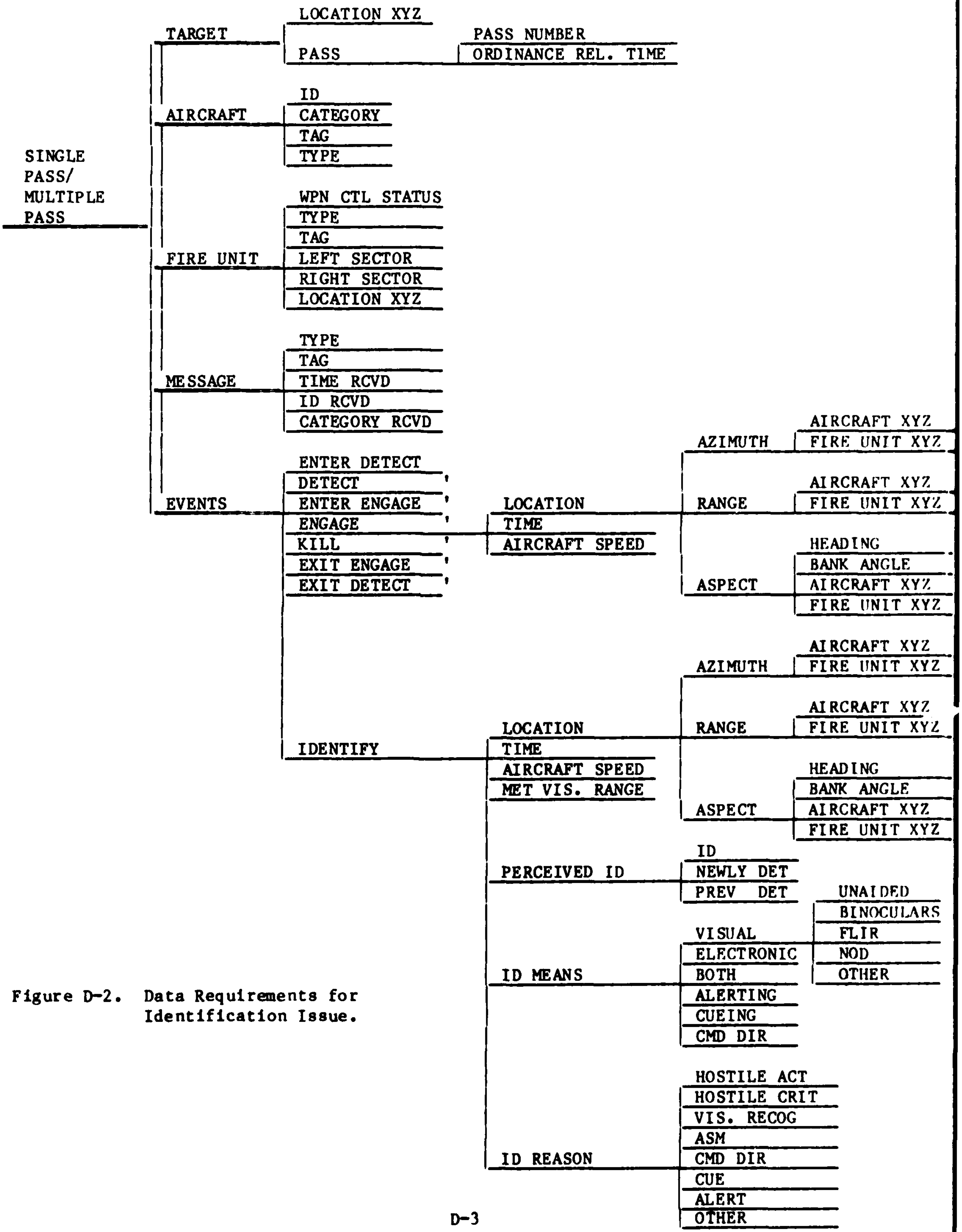


Figure D-2. Data Requirements for Identification Issue.

TABLE D-1. STINGER

	ENGAGEMENT OPPORTUNITIES	DETECTED	CORRECTLY IDENTIFIED	ENGAGED	KILLED
VISUAL	2320	1687	1380	996	743
ELECTRONIC	2700	2134	1572	1035	915
BOTH	1735	1411	1175	792	638
TOTAL	6755	5232	4127	2823	2296

Identification data is compiled on this table for the Stinger weapons system. Similar data would be accrued for the other air defense weapons systems.

TABLE D-2. ROTARY WING

	ENGAGEMENT OPPORTUNITIES	DETECTED	CORRECTLY IDENTIFIED	ENGAGED	KILLED
STINGER	6755	5232	4127	2823	2296
CHAPARRAL	10538	9753	9102	8621	8007
SGT YORK	12312	11631	10135	9276	8753
US ROLAND	10337	9654	9004	8762	7930
HAWK	5950	5001	4897	4736	4332
PATRIOT	6100	5973	5105	4329	4101
TOTAL	51992	47244	42370	38547	35419

Data presented on this table represents engagements of hostile rotary wing aircraft by all air defense weapons systems. A similar table would be developed for fixed wing aircraft.

Included would be a narrative explaining significant weapons system parameters which impact the issue.

TABLE D-3. HOSTILE AIRCRAFT

	ENGAGEMENT OPPORTUNITIES	ENGAGED	KILLED
ROTARY WING	51992	38547	35419
FIXED WING	65337	49962	44276
TOTAL	117329	88509	79695

Rotary wing and fixed wing threat aircraft engagement data is compiled on this table. A similar table would be developed for friendly aircraft.

TABLE D-4. DIRECT IDENTIFICATION

	ENGAGEMENT OPPORTUNITIES	ENGAGED		KILLED	
		TOTAL	PERCENT	TOTAL	PERCENT
HOSTILE AIRCRAFT	117329	88509	75.4	79695	67.9
FRIENDLY AIRCRAFT	81635	20361	24.9	5727	7.0

Data for hostile and friendly aircraft engagements are presented in this table. Engagements would be performed using direct identification methods only. Similar engagements would be run using indirect identification methods, and a table displaying the data developed.

TABLE D-5. IDENTIFICATION ISSUE

	HOSTILE (%)		FRIENDLY (%)	
	ENGAGED	KILLED	ENGAGED	KILLED
DIRECT	75.4	67.9	24.9	7.0
INDIRECT	79.3	72.1	28.3	8.1

Direct and indirect identification data are presented in this table. In addition to data in the table, a narrative presenting additional information which influenced the final results would be presented (e.g.-subservient tables, contributions of C^3I information, affects of ASM, accuracy of identification, etc.). For the hypothetical case, hostile aircraft entering a division area utilizing direct identification methods were engaged 75.4% of the time and, of the total hostile aircraft, 67.9% sustained attrition. At the same time, 24.9% of the friendly aircraft were engaged with 7.0% fratricide. Using indirect identification, hostile aircraft were engaged 79.3% of the time with 72.1% attrition while friendly aircraft were engaged 28.3% of the time with 8.1% fratricide. Thus, indirect identification means improve the effectiveness of air defense weapons systems but increases the probability of fratricide (perhaps prohibitively). All DRs, MOPs, and MOEs would be carefully analyzed to determine which ones were the significant contributors. These would then be highlighted for futher consideration and study.

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